POWER PLANT ENGINEERING

GENERATION - TRANSMISSION - DISTRIBUTION - UTILIZATION

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NRA MEMBER U.S.

WE DO OUR PART

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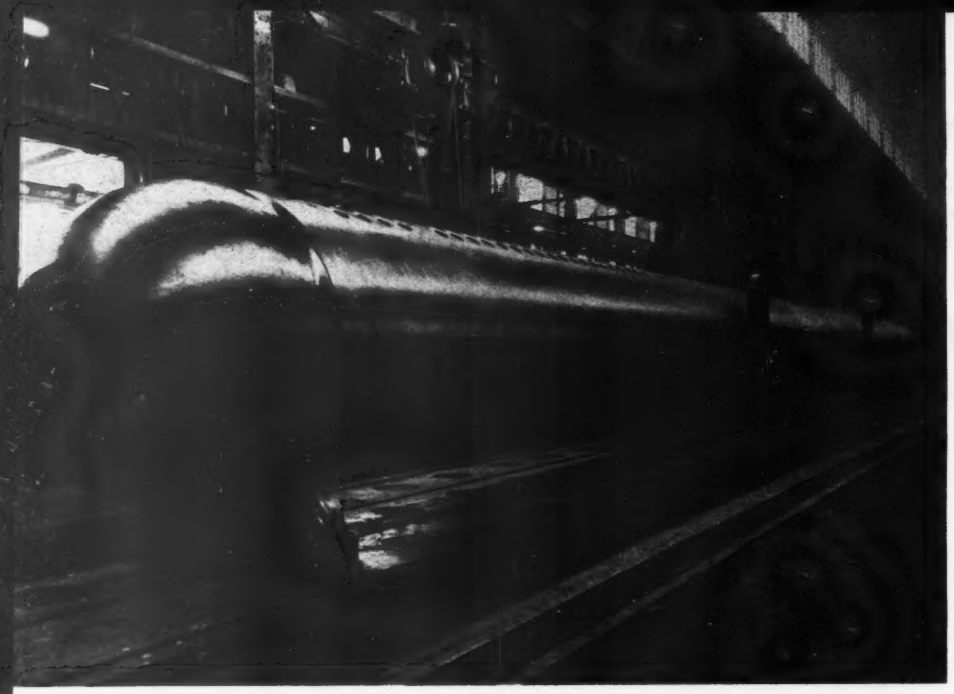

Forged *from a* Single Ingot *of* Steel

MAN'S MASTERY in the use of materials was perhaps never more properly exemplified than it is in this huge polished boiler drum for one of the new boilers for the Port Washington station. Forged from a single solid ingot of steel weighing 392,000 lb., this drum incorporates in its design and construction untold years of man's mental and physical progress. Back of it lies all the accumulated knowledge of the whole science of mechanical, metallurgical and electrical engineering. Simple enough in its contour, it is nevertheless a highly complex product of scientific knowledge. All the slaves that built all the pyramids, all the artisans that labored on all the ancient temples, could not have produced it. It is a product of the machine and *only* of the machine. In its five and a quarter inch steel walls are crystallized the results of years of chemical and metallurgical research; on its smooth surfaces is inscribed the long story of the mechanical engineers' art, of the development of powerful lathes and shapers, boring and cutting tools, hydraulic presses, powered by electricity, handmaiden of all the arts. Behind its purposes lies the history of power—the steam engine and turbine, the whole story of the development of the boiler, of the generation and distribution of electric power. Indeed there is immeasurably more to the story of this boiler drum than is presented in the article on page 366 but to those familiar with the development of engineering, the story presented there will suffice and be of considerable interest.

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There is a great difference between a 1400 lb. pressure boiler drum and a clean white shirt but like the boiler drum the white shirt also has an interesting story back of it. Twenty-five years ago, the clean white shirt was still largely the result of the household wash woman's labor. There were few commercial laundries and those that did exist made use of a great deal of hand labor. Today the modern laundry is a highly developed element of our civilization, one upon which our great hotels, hospitals, travel agencies, place serious dependence. Imagine, for example, the task of washing 50,000 soiled shirts in 24 hr.! Yet that's exactly what the Little Falls Laundry did not long ago—called for them at a point over 200 miles away, washed them and delivered them all in a matter of 48 hr., a task virtually impossible by hand. The power plant of such a laundry is only one item in its makeup but it is an important one, well worthy of your consideration in this issue.

• • •

Aside from the selection of the proper kind of equipment, no element of power station design deserves more attention than the piping. The piping constitutes the circulatory system of the plant and if improperly installed is subject to as many disorders as that of the human system. Lynn Millspaugh, who presents an article on pipe bends in this issue, has had a lot to do with the design of piping systems. As chief engineer of George B. Limbert & Co. he devised a method of calculating pipe bends which not only simplified the work involved but proved a great time saver. This method is described and presented on page 358 for your benefit. It looks a little complicated but it is really quite simple and if you follow through the specimen problem you will readily get the hang of it.

• • •

"Hydroelectric station flies," which is the title of the article on page 385, has nothing to do with the ordinary household variety of fly, indeed it has nothing to do with flies at all. It concerns the building of a hydroelectric plant on a jungle covered island in the Dutch East Indies. Although not a large plant the transportation problems involved proved almost insurmountable until someone conceived the daring idea of flying the equipment in by airplanes. How this was accomplished, details of the loads carried and the kinds of planes used form an interesting story and indicates new possibilities for the use of the airplane.

WITH THE EDITORS

Diesel Research

CHANGING CONDITIONS and technical advances in our field often bring about perplexing difficulties in related industries. For instance, the development of cracking processes to give greater gasoline yields from crude oils has had a tremendous influence on power generation.

As a result of these technological advances in the petroleum industry, fuel characteristics changed. These changes affected internal combustion engines most seriously although oil fired boilers did not escape without some perplexing problems when the residue from the cracking stills began to find its way into Bunker C supplies.

These residues have a much steeper viscosity characteristic and many of them precipitate carbon at or slightly above normal atmospheric temperatures. New methods of heating, involving only the oil actually being used, and realization that the viscosity, and not the temperature of the oil at the burner, was the important factor has led to a more or less satisfactory solution.

In the internal combustion engine field, the problem first appeared important to the automotive industry. The new fuels had a tendency to knock—a most disconcerting noise to the owner of a new automobile. Although the engine was soon vindicated and the trouble, brought home to the true offender, eliminated to a certain extent by the addition of lead compounds, the difficulty was solved only after years of intensive coöperative research by the automotive and fuel interests.

More recently, the development of the high speed unit has focused attention of the problem from still another quarter, the Diesel engine builder. Strange to say, the problem of the Diesel is altogether different from that of the gasoline engine. Fuels that run smoothly in the gas engine knock in the Diesel. In one case the fuel is all in the cylinder in gaseous form at the beginning of combustion; in the other it is partially injected as a mist during combustion.

Testing technique and test engines, highly developed for gasoline engine research, have been found wanting when applied to the Diesel field. Higher combustion temperatures and pressures, and the heavier fuels make reproduceable test results difficult or impossible. The matter is, however, the subject of investigation in practically all civilized countries of the world. Producers of fuel and manufacturers of engines are united in an investigation that should add much to our knowledge of the theory and practice of the Diesel engine. Most of these men took part in, and all are familiar with, the closely related gasoline engine investigation. Suitable standardized tests should soon be developed and the work carried to a satisfactory conclusion.

The work is being actively backed by the engineering societies as part of a formal and extensive research program. Pending complete organization of this work, individual effort by a voluntary committee of a dozen or more research men most interested in the problem promises to clear up much of the preliminary work.

Coal Trends

AS BROUGHT OUT in discussion at the recent course on Coal Utilization at the University of Illinois, sizing of coal, removal of impurities and dust, and treatment to render coal-handling dustless are being given increased attention, to the end that a uniform product, convenient and adapted to the needs of the user may be supplied to him.

In the matter of sizing, it would seem that this has gone to extremes, as some 60 sizes or more are offered by various mine operators, running to irregular and unnecessary complexity. In fact, the suggestion was made by Joseph Harrington in his address on coal selection that sizing might well be reduced to 4 main classes; about 6 in. to 3½ in., 3½ to 2 in., 2 to 1¼ in., 1¼ to 0 in.; the last class might be subdivided for small stoker and domestic use into 1¼ to ¾ in., ¾ to ⅜ in., ½ to 5/16 in., 5/16 to 0 in. The divisions are about as he suggested and if sizes were kept to these limits would seem to give all the diversity needed.

For removal of impurities, hand picking was favored for the larger sizes, say above 2 in. Smaller sizes to be cleaned by washing and/or by dedusting on a screen through the use of an air blast. Careful handling at the face of the seam and in loading was favored to reduce the amount of non-combustible carried to the tipple. Treatment to remove most of the ash-forming content is likely to increase the cost to consumer beyond practical limits but tests have shown that reasonable removal, say to reduce ash from 15 per cent to 8 per cent, will increase the efficiency of the boiler plant to a marked degree, as well as cutting down freight per ton of actual fuel. The practical limit of cleaning seems to be when the recovered fuel is about 80 per cent of the original coal as brought from the mine.

In the matter of treatment to prevent dust in handling spraying with oil or with calcium chloride is being practiced. Several mines are treating at the mine, also dealers are treating in their yards with great satisfaction to customers because of the cleanliness secured, and, in the case of oil treatment, better working in stokers, better ignition in the furnace and some gain in boiler plant efficiency. The cost per ton for treatment is not great and, certainly for residence and apartment use at least, would seem to be well warranted by the advantages gained.

Power plant managers will do well to keep posted on these forward trends in fuel preparation and to take advantage, in their buying of coal, of the advances which may be made in order to get more economical plant operation. Least cost per 1000 lb. of steam or per unit of industrial plant product is the goal aimed at. It may be attained as well by increase in boiler efficiency or by reduction in the cost of handling coal and ashes and in plant maintenance as by a few cents lower cost per ton of fuels.

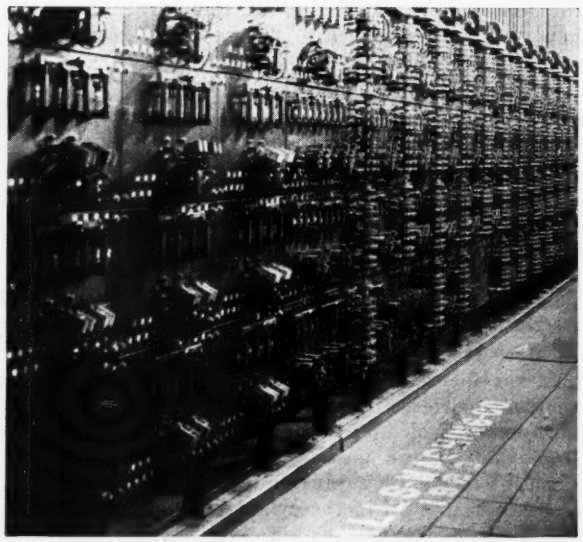
PULVERIZED COAL *for*

Power plant for the World's Largest Laundry at Little Falls, N. J. delivers 500,000 gal. of water daily and furnishes as high as 36,000 lb. of steam per hour. New pulverized coal boilers expected to save over 10 Percent of present fuel bill.

IN GATHERING material for articles on new power plant installations, it often happens that the institution which the plant serves is of greater interest than the power plant itself. This was the case when we visited the Little Falls Laundry Co. at Little Falls, New Jersey, for the purpose of writing this article on their new boiler plant. True, we found an interesting power plant, one adequate in every way to fill their present requirements, but in order to understand this plant it was necessary to know something of its history. With the exception of the new pulverized coal fired boiler installation, this plant is an old one, one that grew up with the institution it serves. A plant of this kind has not, of course, the many modern and desirable features that a new plant may have, but often it is of greater interest from a purely engineering point of view because of many special, often ingenious, features which have been incorporated from time to time in order to adapt it to changing conditions and the gradual expansion of the industry.

The story behind the Little Falls Laundry Co. is one of distinct human interest—one carrying the growth of an idea from its inception to a high order of success. It concerns the career of six brothers, the Vander May brothers, who started out in 1912 with but a single horse and wagon and a small wooden shack and formed the Little Falls Washing Co. in their home town a few miles from Paterson. It was an humble beginning. At first only a few friends of the brothers, together with those families secured by personal solicitation, were served. The quality of the work, however, and the unfailing promptness of service soon brought new patrons and friends.

Originally, "Wet Wash" was the only service offered but the rapid increase of patrons from a mere handful to hundreds and then thousands brought the



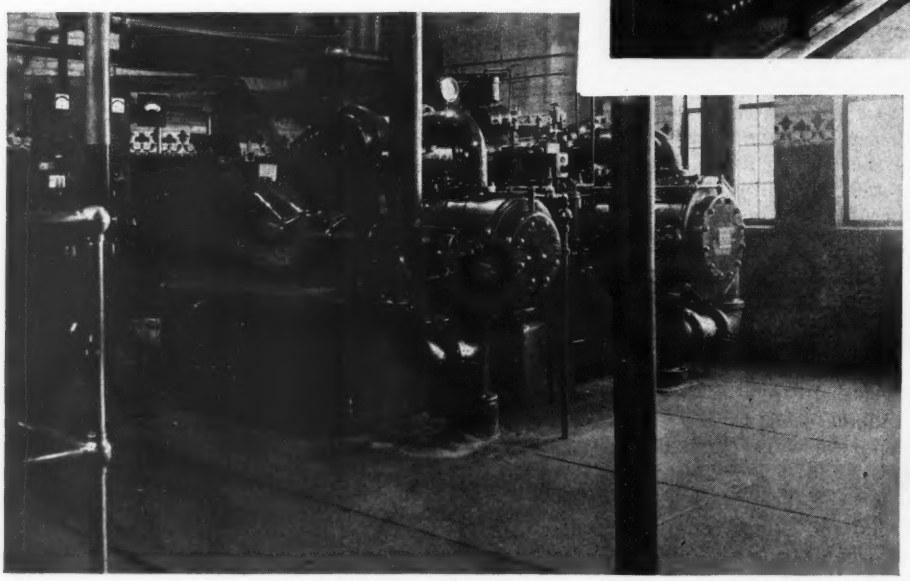


Fig. 2. Above: Automatic Control and Contactor Panels for Washers and Tumblers

Fig. 3. Left: Air Compressor Driven by Synchronous Motor

Little Falls Laundry Plant

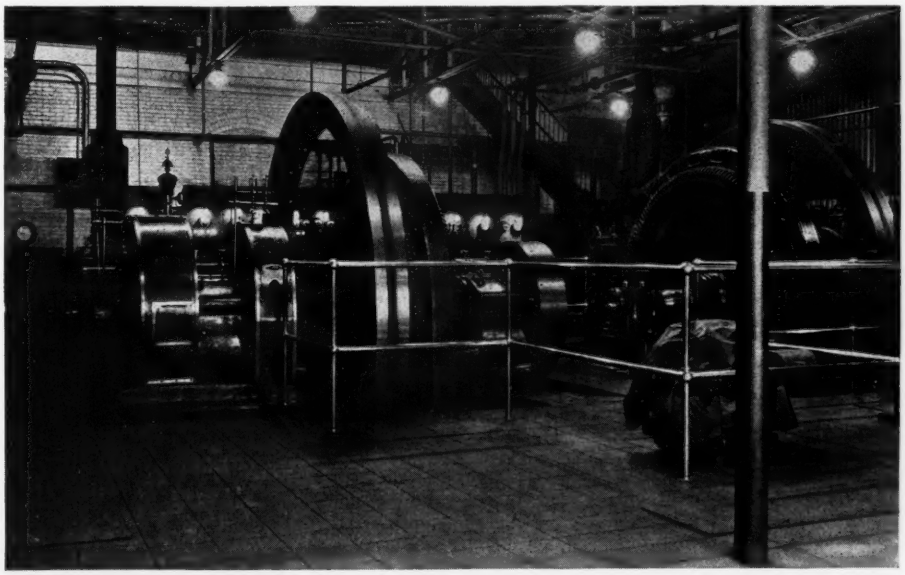
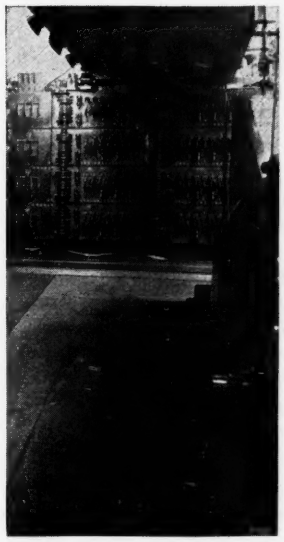


Fig. 1. Right: Engine Room at the Little Falls Laundry Plant

need for other services. This necessitated numerous changes in the original plant. Additions were made to the building but soon these too were outgrown. In 1917 a larger building, brick,



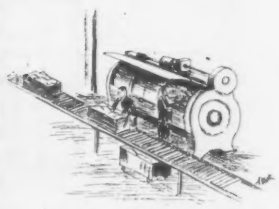
was erected. Still the growth continued and further additions were made in 1922.

In response to customers' wishes, new and more complete laundry services were added and popularized. The idea of 1912 had become an institution; no longer was it just a "washing" company, it was *the* laundry for thousands of families in northern New Jersey. In keeping with this thought the name was changed in 1926 to the Little Falls Laundry Co. and plans were formulated for the erection of a larger, ultra-modern, steam generating and power plant which would serve the future as well as the present. Since then, even through the deepest period of the depression, extensive additions have been made, the latest being the erection of a splendid new administration building and a new modern rug cleaning building—for not only is this a laundry but it also furnishes complete dry cleaning service. The single horse and wagon of 1912 has given way to a fleet of one hundred high speed motor trucks which extend daily service from Greenwood Lake in New York State to Seaside Park half way down the New Jersey coast. This is said to be the largest laundry in the world.

It is not our purpose here to describe the laundry; needless to say it comprises the finest and most modern equipment available, but it must be obvious that an institution such as this has considerable power requirements. Not only is a considerable amount of electric power necessary to operate the numerous washers, extractors, conveyors, ironers, etc., but enormous quantities of hot and cold softened water are necessary. For heating and drying a great amount of both high and low pressure steam is required. Some idea of the water requirements may be had when it is known that in each washer the water is changed from 7 to 10 times during each washing, over 600 gal. of water being used. Multiply this by dozens of washers and consider that a large portion of this water must be heated to a temperature of from 160 to 180 deg., add to that the fact that steam is used in all the dryers and ironing and pressing machines as well as for a considerable amount of the hand pressing and you realize why large quantities of steam are necessary.

The power plant fulfilling these requirements at the Little Falls Laundry reflects the gradual growth of the institution itself. Until the addition of the new pulverized coal fired boiler it consisted of 4 h.r.t. boilers rated at 300 hp. each and 2 engine driven generator units, one of 292 kw. capacity and the other of 400 kw. capacity.

The small engine unit went into service about 1922 together with two of the h.r.t. boilers. The laundry business grew so rapidly, however, that in 1925 the present power plant was built. Two new boilers and the large engine were added. This equipment has given adequate service for 8 yr. but now because of added load more boiler capacity is necessary and a new 6000 sq. ft. boiler with an overall rating of 786 hp. has just been installed. This new unit it is expected



will be able to carry the entire plant load under normal conditions but the old units will be kept in reserve until another new boiler can be installed.

The new unit is an Erie City bent tube low head type water tube boiler with 6000 sq. ft. of heating surface, exclusive of the water walls with which the furnace is equipped. This unit will be operated at from 100 to 250 per cent rating and at the latter it is expected to carry the entire plant. The furnace is equipped with sides and rear water walls, and will operate under natural draft. The brickwork was supplied by the Erie City Boiler Co. while the installation was done by the Mac Engineering Co. of New York. It is fired with pulverized coal, an Erie City unit pulverizer being provided. This pulverizer, as may be noted in the accompanying drawing, is located on the floor directly in front of the boiler and has a capacity of 4 tons per hr. It is driven by a 60-hp. electric motor, and controlled by a Bailey Meter Co. control system. All regulating equipment with steam flow meters, steam gages, draft gages and CO_2 meters are mounted on a single panel, on the operating floor.

The boiler is completely equipped with a full complement of boiler accessories, Diamond soot blowers of the valve-in-head type, Consolidated safety valves, Yarway quick opening blowoff valves, Reliance gage columns and Copes feedwater regulators.

Forced draft is supplied by a Buffalo Forge Co. forced draft fan mounted on a platform above the operating floor. Coal handling equipment was furnished by the Robins Conveying Belt Co.

Coal is delivered to the plant by truck. It is dumped into a hopper and then carried to the top of the boiler house by a bucket type elevator which in turn delivers to a horizontal belt conveyor over a magnetic separator. The belt delivers the coal into a steel overhead bunker from which it flows by gravity to the pulverizer.

Ash is handled by the same ash sluicing system which served the old boilers. This system is simple and effective, indeed highly necessary at a plant of this kind where the presence of dust might incur large spoilage in the laundry. By sluicing the ash directly into a tile tank ash is disposed of with no production of dust at all.

The new boiler is supplied with feedwater by the same feed pumps and feedwater heater that have served the old boilers. These are Davidson reciprocating steam driven pumps, exhausting directly into the heater coils and located in the old boiler room as shown in the drawings. Water for the entire plant is taken from a small stream near the plant, passed through a clarifier and then into a Permutit Zeolite treating system. From the treating system it is sent to an economizer where the temperature is raised from 40 to 100 deg. F. and from there it is delivered to the hot water heaters where the temperature is further raised to from 160 to 180 deg. F. at which temperature it is sent to the wash room. The Permutit softener has a capacity of 1000 gal. per min.

For boiler purposes, about 40 per cent make up is required. This water is taken from the economizer and heated to approximately 200 deg. in a Whitlock closed feedwater heater. All returns from all over the plant are delivered to this heater. Every machine in the laundry is equipped with its individual trap and there are also traps along all the main distribution lines.

Steam for heating the water required throughout the plant is obtained from the engines and the various steam driven auxiliaries. The engines exhaust at about 2 lb. back pressure which is used both for heating water and for process purposes in the laundry. The plant uses about 800 gal. of water per minute from 7 a.m. to 5:30 p.m.—close to a half million gallons a day!

Ordinarily, about 28,000 lb. of steam per hr. is required to serve this plant but on Monday and Tuesday the steam demand runs up to 36,000 lb. an hr. High pressure steam is needed for many purposes; shirt ironers, pressing machines, flat ironers, drying tumblers are all supplied with steam at 100 lb. pressure. Condensate from all these devices is returned to the feedwater heater.

The new boiler will feed into the existing 100-120 lb. distribution system but since the pressure on the

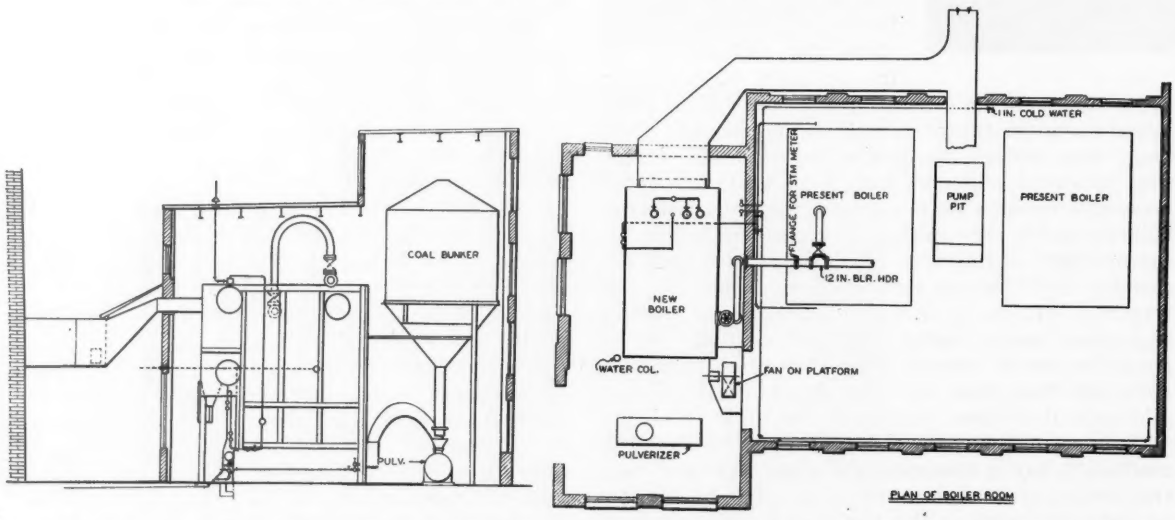


FIG. 4. PLAN AND ELEVATION OF THE NEW BOILERPLANT, SHOWING ITS RELATION TO EXISTING BOILER EQUIPMENT

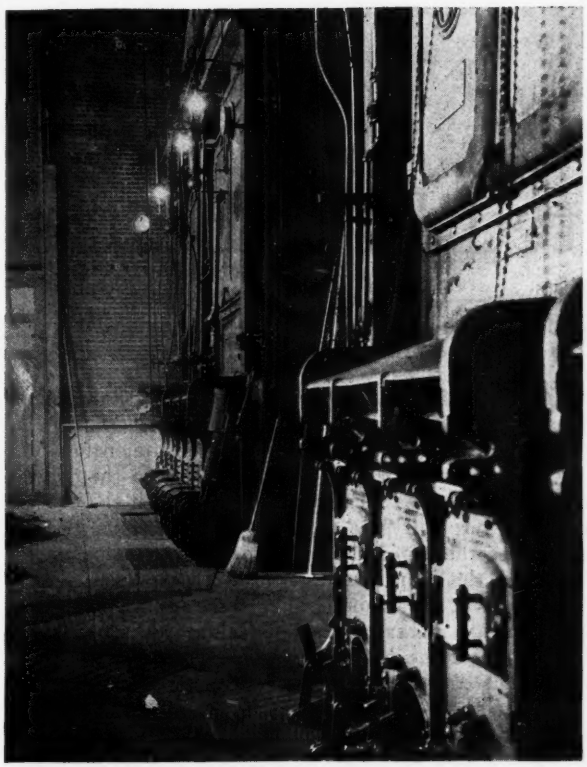


FIG. 5. A VIEW OF THE OLD BOILERS

new unit will be 150 lb. reducing valves will be interposed. The engines, however, will take steam at 150 lb. pressure.

An important feature of this plant are two large exhaust fans and two intake fans which together with an air washer constitute an air conditioning system for the entire institution. In summer when the outside temperature is 85 deg. the air in the wash room is maintained at 70 deg. This contributes greatly to the comfort of the employees and results in more effective work on their part.

With regard to the generating room, little need be said. The two generating units consist of first, a 20 by 42 in. Hooven, Owens, Rentschler, Hamilton Corliss engine direct connected to a 292-kw., 240-v., 60-cycle, 2-phase General Electric generator, and second, a 22 by 42 in. Hamilton engine of the same type connected to a 400-kw., 2-phase G. E. generator.

The generators are excited by separately driven exciters, first, a 50-hp., 1155-r.p.m., 220-v., 127-amp., 2-phase induction motor connected to a 30-kw., 125-v., Crocker-Wheeler d.c. generator and the other a 35-kw. G.E. generator driven by a 3400-r.p.m. General Electric turbine.

The electrical output is controlled by a 13 panel switchboard which occupies one end of the engine room.

In a plant of this kind a considerable amount of compressed air is required. This is supplied by an Ingersoll-Rand air compressor, driven by a 150-kv.a. General Electric synchronous motor arranged for push button control.

In addition to the main generating and distribution switchboard, there are also installed in the engine room the contactor and control panels for all the washers and cleaning machines in the laundry. In a laundry of this size with so large a number of washers it is desirable to have the control mechanism directly under the observation of the operating engineers. These contactors control the periodic reversal of the washers and tumblers.

Conclusion

It is evident from the foregoing description that this plant is well equipped to maintain reliable and efficient service. With the new boilers it is expected that the boiler efficiency will be maintained at from 78 to 80 per cent. Since the old boilers are doing only about 68 to 70 per cent, there will be a gain of 10 per cent due to the installation of the new unit.

At the present time coal consumption amounts to around 140 tons a week, about 7000 tons a year, but by the use of the new pulverized coal fired boiler, considerable more than 10 per cent of this amount will be saved because all the "banked" hours will be saved. In summer time there will be no boiler in use between Friday afternoon and Monday morning whereas in winter a boiler has to be maintained in a banked condition during that period.

In concluding this description we wish to express our indebtedness to the Vander May brothers for courtesies extended in gathering material for this article and to Otto E. Goldschmidt, consulting engineer of New York, who designed the new boiler plant, for information regarding this installation.

In a recent address Dr. Harvey N. Davis, President of Stevens Institute, pointed out and endorsed the prediction of General Rees, Vice-President of American Telephone and Telegraph Co. that by 1938 there will be a shortage of technical men, from skilled workmen up to trained engineers. This will come about by changing of technical men into other fields, by retirement and by reduction of the hundreds of engineers graduated below the requirements of industry. The shortage is likely to arise suddenly and unexpectedly, particularly as engineering courses are now stressing a knowledge of economics and industrial management as a necessary adjunct to engineering training, so that many engineers are stepping into executive and managerial positions. Dr. Davis believes that engineering will not be an overcrowded profession for the next 25 yr., spite of the seeming condition at the present moment.

This address was a forerunner of a Choosing-a-Career Conference held June 26-28 at L. Bamberger & Co., Newark, N. J., where 31 leaders of American industry outlined career possibilities in their respective fields, covering exploration, broadcasting, advertising, foods, building, railroading, insurance, entertainment, publishing, retailing, finance.

Storage of heat in hot water for process work is an effective means for evening up demands on the boiler plant, saving heat in surplus exhaust steam, reducing boiler capacity required and ensuring ample supply of heat at times of peak demand. The cost is generally considerably less than for standby boiler capacity and plant efficiency is better.

An Easy Method of Figuring Tilted Pipe Bends

By Lynn W. Millspaugh*

IN THE DESIGN and construction of piping systems, the determination of the actual dimensions and angles of the various pipe bends involved is a task involving considerable effort and skill. The available data for figuring such bends usually must be taken from the general piping layout drawings and in many instances the dimensions available are not the real dimensions but merely projections of the bend upon the coordinates of the general piping layout. If the coordinates necessary to establish the full dimensions of a particular bend coincide with the coordinates of the general layout drawing the dimensions can of course be taken off directly but when the coordinates of the bend and those of the layout drawing are displaced, the problem is more complex. It is with the latter condition that this discussion is involved.

The accompanying chart and tables were devised to make the calculation of pipe bends more simple and to speed up the process. By means of the data presented here and a table of trigonometric functions to be found in any handbook, all the actual dimensions of any pipe bend may easily be figured from certain basic dimensions.

To explain more clearly, consider for example the small piping layout shown in Fig. 1, which shows among other things the piping between a pump and a tank. It is desired to know accurately the dimensions of this pipe bend.

With the exception of this bend the dimensions of all of the piping can be taken directly from the drawing. None of the dimensions available from the drawing, however, will give the "real" dimensions of the bend since the coordinates of the bend are not coincident with the coordinates of the drawing. By means of the data in the accompanying tables and charts and with the aid of trigonometric tables, the projected dimensions of the bend can be made to give the real dimensions of the bend.

The method involved is quite simple and is illustrated by means of Fig. 2. This is a detail of the bend shown in Fig. 1 with the "projected" dimensions indicated. Complete details are required as to both center to face dimensions, the actual angle of the bend and the degree of turning (if any) of the flanges so that the bolt holes will straddle the vertical and horizontal center lines.

Referring now to the chart, Fig. 3 and to the tables, calculations from the known values are as follows:

*Formerly chief engineer, Geo. B. Limbert & Co., Chicago.

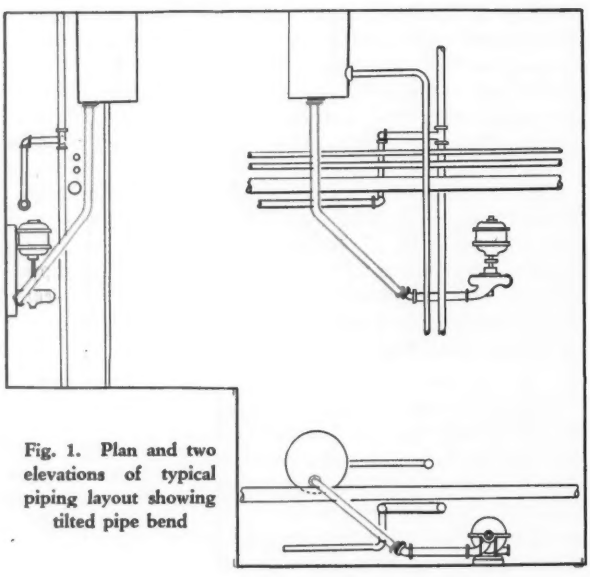


Fig. 1. Plan and two elevations of typical piping layout showing tilted pipe bend

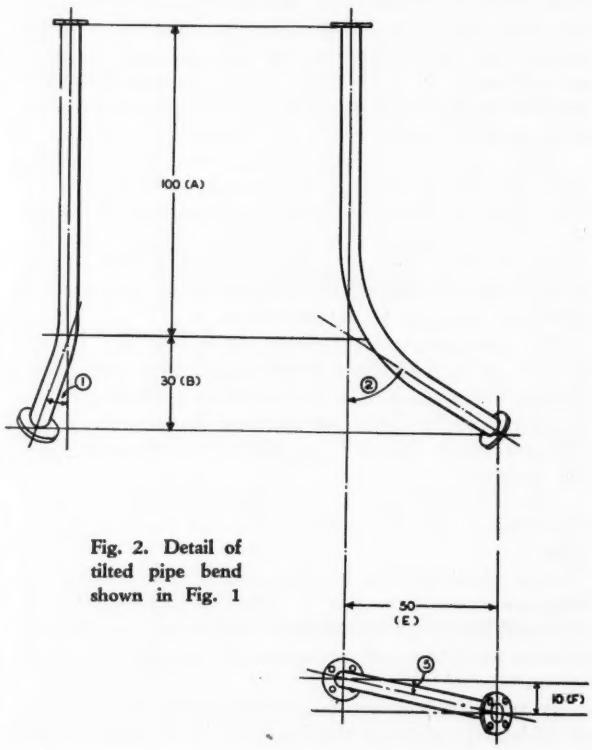


Fig. 2. Detail of tilted pipe bend shown in Fig. 1

TABLE I. FORMULAS FOR CALCULATING DIMENSIONS OF PIPE BENDS

A	$\sqrt{H^2+L^2}$ = L SEC ∠ ② = H COSEC ∠ ② = $\frac{H}{\text{SIN}\angle②}$ = $\frac{L}{\text{COS}\angle②}$
	$\sqrt{C^2+P^2}$ = C SEC ∠ ⑦ = P COSEC ∠ ⑦ = $\frac{P}{\text{SIN}\angle⑦}$ = $\frac{C}{\text{COS}\angle⑦}$
	$\sqrt{U^2+S^2}$ = S SEC ∠ ① = U COSEC ∠ ① = $\frac{U}{\text{SIN}\angle①}$ = $\frac{S}{\text{COS}\angle①}$
B	$\sqrt{J^2-E^2}$ = J COS ∠ ② = E COT ∠ ②
	$\sqrt{K^2-F^2}$ = K COS ∠ ① = F COT ∠ ①
	$\sqrt{D^2-N^2}$ = D COS ∠ ⑦ = N COT ∠ ⑦
C	$\sqrt{L^2-G^2}$ = L COS ∠ ③ = G COT ∠ ③
	$\sqrt{M^2-H^2}$ = M COS ∠ ④ = H COT ∠ ④
	$\sqrt{A^2-P^2}$ = A COS ∠ ⑦ = P COT ∠ ⑦
D	$\sqrt{F^2+J^2}$ = J SEC ∠ ③ = F COSEC ∠ ③ = $\frac{F}{\text{SIN}\angle③}$ = $\frac{J}{\text{COS}\angle③}$
	$\sqrt{B^2+N^2}$ = B SEC ∠ ⑦ = N COSEC ∠ ⑦ = $\frac{N}{\text{SIN}\angle⑦}$ = $\frac{B}{\text{COS}\angle⑦}$
	$\sqrt{T^2+R^2}$ = R SEC ∠ ④ = T COSEC ∠ ④ = $\frac{T}{\text{SIN}\angle④}$ = $\frac{R}{\text{COS}\angle④}$
E	$\sqrt{J^2-B^2}$ = J SIN ∠ ② = B TAN ∠ ②
	$\sqrt{N^2-F^2}$ = N COS ∠ ⑤ = F COT ∠ ⑤
F	$\sqrt{K^2-B^2}$ = K SIN ∠ ① = B TAN ∠ ①
	$\sqrt{N^2-E^2}$ = N SIN ∠ ⑤ = E TAN ∠ ⑤
	$\sqrt{D^2-J^2}$ = D SIN ∠ ③ = J TAN ∠ ③
G	$\sqrt{L^2-C^2}$ = L SIN ∠ ③ = C TAN ∠ ③
	$\sqrt{P^2-H^2}$ = P COS ∠ ⑥ = H COT ∠ ⑥
H	$\sqrt{M^2-C^2}$ = M SIN ∠ ④ = C TAN ∠ ④
	$\sqrt{P^2-G^2}$ = P SIN ∠ ⑥ = G TAN ∠ ⑥
	$\sqrt{A^2-L^2}$ = A SIN ∠ ② = L TAN ∠ ②
J	$\sqrt{B^2+E^2}$ = B SEC ∠ ② = E COSEC ∠ ② = $\frac{E}{\text{SIN}\angle②}$ = $\frac{B}{\text{COS}\angle②}$
	$\sqrt{D^2-F^2}$ = D COS ∠ ③ = F COT ∠ ③
K	$\sqrt{B^2+F^2}$ = B SEC ∠ ① = F COSEC ∠ ① = $\frac{F}{\text{SIN}\angle①}$ = $\frac{B}{\text{COS}\angle①}$
L	$\sqrt{C^2+G^2}$ = C SEC ∠ ③ = G COSEC ∠ ③ = $\frac{G}{\text{SIN}\angle③}$ = $\frac{C}{\text{COS}\angle③}$
	$\sqrt{A^2-H^2}$ = A COS ∠ ② = H COT ∠ ②
M	$\sqrt{C^2+H^2}$ = C SEC ∠ ④ = H COSEC ∠ ④ = $\frac{H}{\text{SIN}\angle④}$ = $\frac{C}{\text{COS}\angle④}$
N	$\sqrt{E^2+F^2}$ = E SEC ∠ ⑤ = F COSEC ∠ ⑤ = $\frac{F}{\text{SIN}\angle⑤}$ = $\frac{E}{\text{COS}\angle⑤}$
	$\sqrt{D^2-B^2}$ = D SIN ∠ ⑦ = B TAN ∠ ⑦
P	$\sqrt{G^2+H^2}$ = G SEC ∠ ⑥ = H COSEC ∠ ⑥ = $\frac{H}{\text{SIN}\angle⑥}$ = $\frac{G}{\text{COS}\angle⑥}$
	$\sqrt{A^2-C^2}$ = A SIN ∠ ⑦ = C TAN ∠ ⑦
R	$\sqrt{D^2-T^2}$ = D COS ∠ ④ = T COT ∠ ④
S	$\sqrt{A^2-U^2}$ = A COS ∠ ① = U COT ∠ ①
T	$\sqrt{D^2-R^2}$ = D SIN ∠ ④ = R TAN ∠ ④
U	$\sqrt{A^2-S^2}$ = A SIN ∠ ① = S TAN ∠ ①

TABLE II. FORMULAS FOR CALCULATING ANGLES OF PIPE BENDS

∠	SIN	COS	TAN	COT	SEC	COSEC
①	F/K U/A	B/K S/A	F/B U/S	B/F S/U	K/B A/S	K/F A/U
②	E/J H/A	B/J L/A	E/B H/L	B/E L/H	J/B A/L	J/E A/H
③	G/L F/D	C/L J/D	G/C F/J	C/G J/F	L/C D/J	L/G D/F
④	H/M T/D	C/M R/D	H/C T/R	C/H R/T	M/C D/R	M/H D/T
⑤	F/N	E/N	F/E	E/F	N/E	N/F
⑥	H/P	G/P	H/G	G/H	P/G	P/H
⑦	P/A N/D	C/A B/D	P/C N/B	C/P B/N	A/C D/B	A/P D/N

ANGLES ⑤ & ⑥ ARE THE CLOCKWISE TURNING OF FLANGES ON LEGS A & D RESPECTIVELY.

One center to face dimension (A) is available directly from the drawing. This is 100 (inches or feet or whatever unit may be used). The other center to face dimension (D), however, is not directly available but must be calculated by means of any one of the formulas indicated opposite D in the table. Inspection of these, however, reveals that we lack complete data to solve either of these three formulas. In the second one, for example, $\sqrt{(B^2+N^2)}$, we know B but we do not know N. N, however, can be calculated from E and F (both of which we have) by means of the first formula shown under "N," i.e., $\sqrt{(E^2+F^2)}$.

Thus $N=\sqrt{(E^2+F^2)}=\sqrt{(50^2+10^2)}=50.99$. Having a value for N, we can now calculate D by means of the formula $\sqrt{(B^2+N^2)}=\sqrt{(30^2+50.99^2)}=59.16$. In a similar manner the actual angle of the bend (angle 7) may be calculated by means of the formulas opposite angle 7 in Table II. Inspecting this table we select a formula containing terms for which we have known values, for example, the second tangent formula, N/B. Thus $N/B=\frac{50.99}{30}=1.6996=\tan 59°\ 32'$.

From this illustration of the method involved it is an easy matter to calculate as many values as necessary as shown below:

1. $\sqrt{(E^2+F^2)}=\sqrt{(50^2+10^2)}=50.99\ldots..(N)$
2. $\sqrt{(B^2+N^2)}=\sqrt{(30^2+50.99^2)}=59.16..(D)$
3. $N/B=\frac{50.99}{30}=\tan 59°\ 32'\ldots..(\text{Angle } 7)$
4. $F/E=\frac{10}{50}=\tan 11°\ 19'\ldots..(\text{Angle } 5)$
5. $F/D=\frac{10}{59.16}=\sin 9°\ 44'\ldots..(\text{Angle } 3)$
6. $E/B=\frac{50}{30}=\tan 59°\ 2'\ldots..(\text{Angle } 2)$

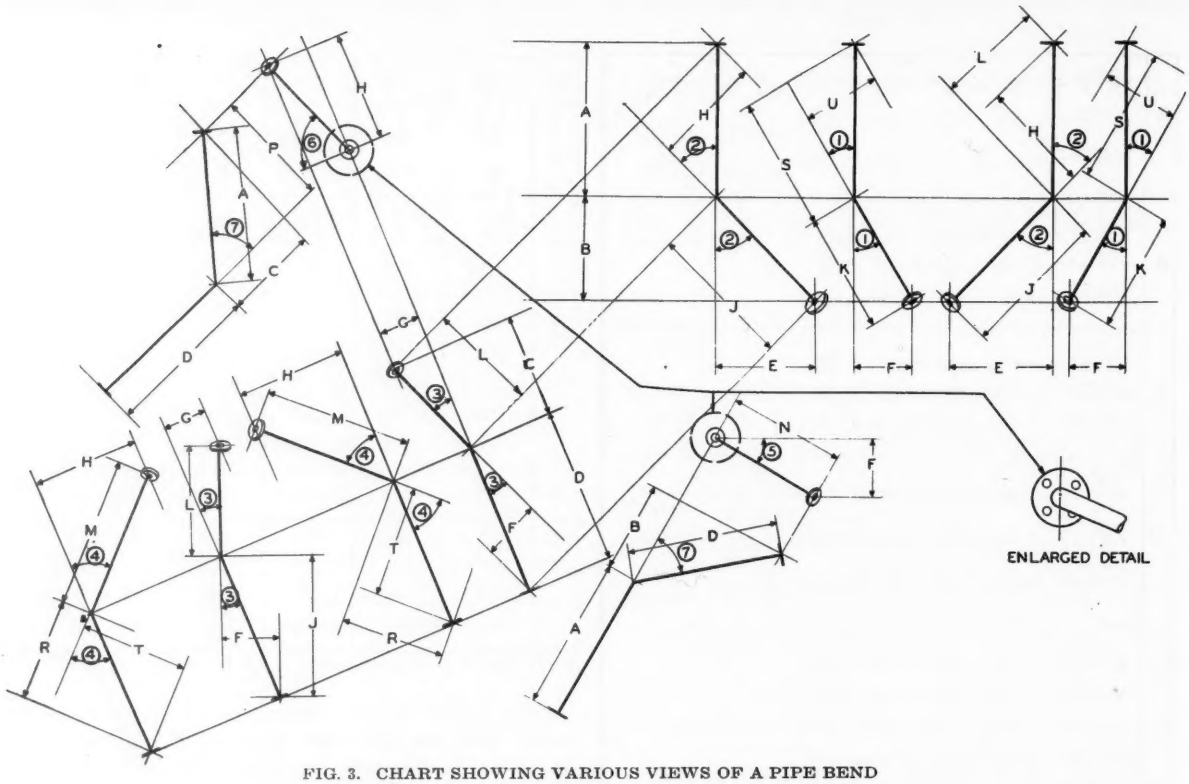


FIG. 3. CHART SHOWING VARIOUS VIEWS OF A PIPE BEND

7. A cos angle 2 = 100 cos 59° 2′ = 51.45..... (L)
8. L sin angle 2 = 51.45 sin 9° 44′ = 8.70..... (G)
9. A sin angle 2 = 100 sin 59° 2′ = 85.75..... (H)

$$10.\ H/G = \frac{85.75}{8.70} = \tan 84°\ 12'\ldots\ldots\ (\text{Angle } 6)$$

Thus we have all the desired values for making the bend. Angle 7, the angle of the bend is 59° 32′. A and D are the center to face dimensions, 100 and 59.16 respectively. Angles 5 and 6 are the degrees of turning on flanges on legs A and D respectively—10° 19′ and 84° 12′ clockwise.

It should be understood that any dimensions whatever which will fix the position of the bend can be used to calculate all other desired values. In actual practice it usually will be found that overall dimensions between centers of valves and fittings and the length of the legs of the bend arrived at by subtracting the center to face dimensions of the fittings or valves.

These tables have given valuable service on many large and important piping jobs and have been found particularly useful in checking clearances when working in close quarters.

The Vanished Dam

THE WOODEN TYPE OF DAM shown in the accompanying photo has been entirely eliminated by the use of modern concrete dams with their great safety and beauty. In 1898 the Tuolumne Water and Electric Co. built a reservoir at Lyons Flat to provide water requirements of the mining area in the vicinity of Columbia, Sonora, Jamestown and Tuolumne. The dam, shown herewith, creating the reservoir was called Lyons dam and was of timber crib construction, 52 ft. in height. This unique dam rendered service for over 30 yr. as an integral part of the Tuolumne water system until its replacement a few years ago by a variable radius, concrete dam 110 ft. in height, which was built by the Pacific Gas & Electric Company, which concern now controls the reservoir.

REHEAT—Practice, Operation *and* Control

Some High Pressure and Reheat Boiler Designs Now in Service in This Country and in Europe

INCREASING PRESSURES and temperatures cause changes in the relative importance of the various heat absorbing surfaces in the boiler unit. With ordinary pressures and temperatures the boiler may absorb as much as 70 per cent of the total heat input to the steam. At extremely high pressures and temperatures with extraction heating and reheat, this may sink to as low as 35 per cent.

Taking Fig. 1 as the modern high pressure boiler unit with conventional convection superheater and reheater surface, water cooled furnace walls, economizer and air heater, it is evident that any increase in allowable boiler pressure, steam or feedwater temperature would necessitate changes giving a decreased ratio of steam making surface.

For any given heat release the furnace size and consequently water wall surface will be fixed so that reduction in steam making surface would be confined to the boiler tubes bringing the primary superheater closer to the furnace. The ultimate limit would be reached with all the boiler tubes removed, giving, in effect, a radiant superheater with some convection effect, probably a desirable feature.

At the furnace end there is a definite limit beyond which the steam making surface or capacity cannot be reduced unless plain or water cooled refractory surfaces are employed to decrease the heat transfer. On the air heater end there are also definite temperature limits fixed, at the outlet end of the air heater by the dew point of the flue gases and, at the gas inlet end of the air heater, by the maximum temperature to which air for combustion may be heated. This is probably about 600 deg. F. for stokers and 750 deg. F. for pulverized fuel. The maximum temperature rise of the water in the economizer is also limited to the difference between the temperature leaving the highest extraction heater and saturation temperature corresponding to boiler pressure. As pressures approach the critical point the latent heat approaches zero, reducing the heat necessary for actual steam which would, because of the fixed furnace wall surface, force a reduction in economizer surface.

Carrying such a reduction in water cooled surface to its ultimate conclusion and assuming such a design practical, the regulation would be poor. Changes in the rate of firing would have relatively little effect on the steam output from the water walls or on the steam temperature leaving the primary superheater, practically all the effect being felt by the convection reheater coils. This would cause a decided drop in reheat temperature at the lower loads, which could be controlled to a certain extent by means of a steam reheater in series with the gas reheater. The steam reheater would as always act solely as temperature regulator, transferring heat from the furnace to the reheat section, giving a circulating heat load which has the same effect as would feedwater heating by means of live steam. Ultimate development of this type of boiler would closely approach the radiant superheater design without the advantage of flexibility of design and simplicity of operation.

Use of radiant superheat and reheat surfaces would not necessarily change the design greatly but would increase the flexibility. For instance, with a radiant reheater (advisable with variable pressure reheat) in the rear wall, a convection superheater in the first pass and a radiant superheater in the side walls, an economizer and air heater, the boiler would not look much different than Fig. 1. Furnace wall areas not steam cooled may be water cooled thus allowing necessary proportions of water cooled and steam cooled

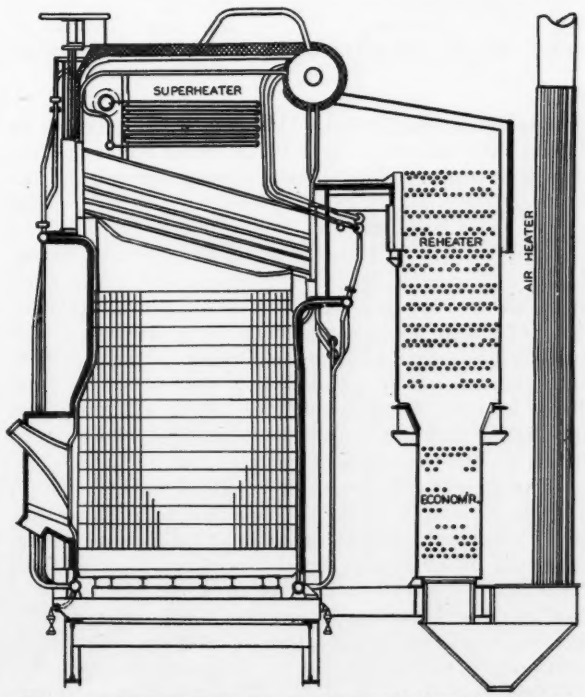


FIG. 1. REHEAT BOILER WITH CONVECTION SUPERHEATER AND REHEATER

surfaces to be made without setting definite limitations.

So far major developments of high pressure radiant superheaters and reheaters have been in connection with bent tube boilers as shown by Fig. 2. This is a unit with a radiant reheater in the rear wall and a combination superheater with the radiant section in the side walls. Some water cooled surface is in the furnace. An air heater is used but the economizer is omitted, its function being largely taken over by the last pass of the boiler. Control of the flame length and contour by manipulation of tertiary and primary air pressures gives further control over the reheat temperature.

In this connection two recent somewhat experimental units are of more than passing interest. The

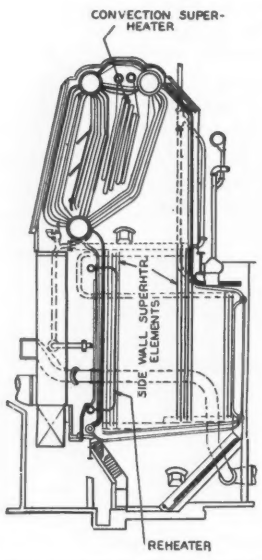


FIG. 2. BENT TUBE BOILER DESIGN

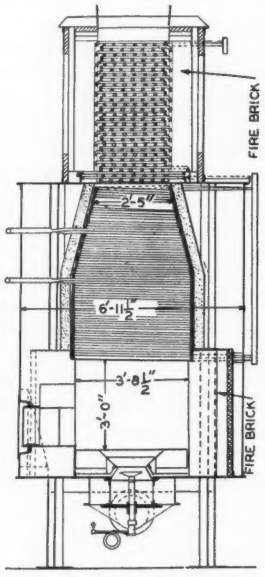


FIG. 3. A 3500 LB. SERIES BOILER

first is the separately fired 1100 deg. F. superheater at Delray; the second is the 3500 lb. series boiler at Purdue University. Neither is designed for reheat but both indicate a trend in American design for high pressures and temperature conditions.

Figure 4 shows the separately fired Delray superheater designed to heat 90,000 lb. of steam per hour from 700 to 1100 deg. F. It is built in three sections, one radiant and two convection. Steam enters at the top, flows downward counter-current to the gas flow into the second or parallel flow convection section. From there it flows through the radiant section and on to the turbine. Oil is used as fuel, the rate of firing giving the necessary temperature control.

The high pressure boiler at Purdue is shown in Fig. 3. This unit consists of two parallel circuits supplied with feedwater at one end and delivering steam from the other at any desired pressure from 1000 to 3500 lb. By varying the fuel to water ratio at any load any quality steam from saturation temperature to a total maximum temperature of 830 deg. F. can be obtained. This limit is set by the tube material.

No steam drum is used. Feedwater flows downward through the 259 sq. ft. convection surface at the top of the unit and then up through the helical furnace section. This latter part has a total tube surface of 101 sq. ft. or a projected area of 64.3 sq. ft. The furnace volume is 64.3 cu. ft. Final primary superheat in this type of boiler is, of course, easily controlled by varying the water-fuel ratio, in effect, changing the superheater area as desired.

Early development work on the series boiler led to the popularly known Calumet boiler of Fig. 1 with the steaming economizer. Further work on drumless boilers with different numbers of parallel circuits led up to the two circuit Purdue boiler.

With little or no water storage extremely quick automatic control of water, air and fuel is necessary to meet variable load conditions. For this purpose in a normal installation the throttle valve would give the primary impulse to change the three supplies mentioned. In the experimental unit steam pressure at the outlet readjusted the oil and air flow to maintain the desired pressure. A temperature element readjusted the water flow to maintain a constant outlet steam temperature. No difficulty was experienced in operating with a 30 per cent variation in load in one or two seconds with a 10 deg. outlet steam temperature variation and a pressure variation of 50 to 100 lb. at 2500 lb. per sq. in.

Vacuum Tube Control

Pressure, temperature and load changes were transmitted from the primary elements by Selsyn motors to Thyratron vacuum tube circuits which supply power to and control the boiler feed and oil supply pump motors. Pressure control indications were from an automatic dead weight piston loaded indicator, temperature control indications from a prodtype thermocouple and load change indications would be taken from a Selsyn motor control on the throttle valve. Displacement of pens on an oil-flow-air-flow meter shifts contacts in the vacuum tube circuit supplying power to a motor driven fan damper. Test operation developed the definite conviction that 3000 lb. operation with a unit of this type represents few complications compared with the ordinary 600 to 1500 lb. units common today.

Addition of a reheater of either the radiant or convection type would not offer insurmountable difficulties. In fact it has already been done in the Benson boiler which can, without a great deal of imagination, be thought of as similar to the series boiler described.

In the original Benson design the furnace was octagonal with vertical tubes arranged in several elements so that they could be removed for repairs. At the bottom, in which might be considered the second pass, were four superheater sections and on alternate (the remaining four) sides were four reheater sections operating at 550 lb. pressure. Above these elements were air heaters. Feedwater was supplied at the top of the furnace, passed downward, reversed and was turned to steam part way back to the top of the furnace. From this point on the tube acted as a radiant superheater. Because of the high temperature of the gases entering the second pass, both the superheater and reheater approached the character of a radiant superheater.

In the second design a square furnace was used and the straight elements replaced by welded helical

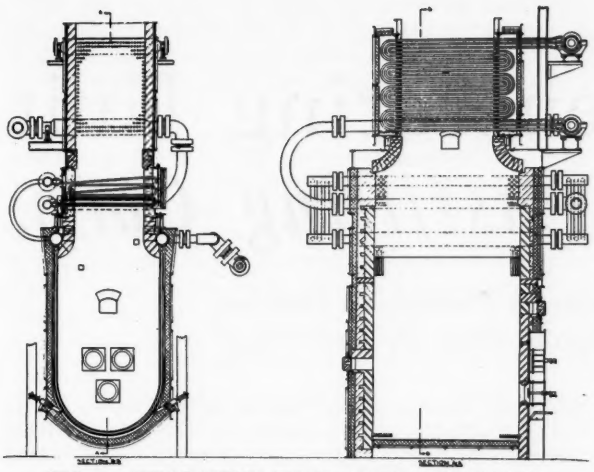


FIG. 4. SEPARATELY FIRED SUPERHEATER FOR 1100 DEG. F. STEAM

tubing. This avoids U-bends and compensated for differences in heat distribution in different parts of the furnace. Increased superheat (860 deg. F.) and higher back pressure on the turbine made it possible to eliminate reheat on these units and the reheater coils were replaced by economizer sections. In this new unit gases from the furnace were split into two instead of eight flues, the gases passing over the superheater, up to the economizer and air heater and out through the stack. Air for combustion was heated to about 750 deg. F.

One of the disadvantages of the Benson boiler was the power consumed by the feed pump working against a pressure of about 4000 lb. Recently the method of operation has been changed and the boiler operates at critical pressure only at maximum load. At partial turbine loads the boiler pressure is reduced in proportion to the electrical load. In other words the turbine throttle controls the boiler pressure rather than a throttle valve in the steam line.

Other foreign designs for high pressures as, for instance, the Loeffler and Brown Boveri, absorb practically all the heat through superheater surfaces. In the former steam from the drum is pumped by steam pump through the superheater. Part of this superheated steam, about 65 per cent, is returned to the evaporator drum, the balance flows to the turbine or to the turbine and steam reheater depending upon the layout of the plant. It is estimated that the boiler feed and circulating pump each require about 9.6 B.t.u. per lb. of steam generated.

Somewhat the same idea is used in the Brown Boveri cascade boiler. Steam is evaporated by superheated steam, but no steam circulating pump is used, steam flow through the superheating elements being induced by pressure drops between stages. A small exciter boiler is used to generate a small amount of steam somewhat above the desired delivery pressure. This may be separately fired if desired.

This pilot steam is heated in a superheater and flows to an evaporator. This evaporator is supplied with feedwater which is partially evaporated by the superheated steam. The combined steam then flows through the second superheater to another evaporator and so on until the desired output is reached.

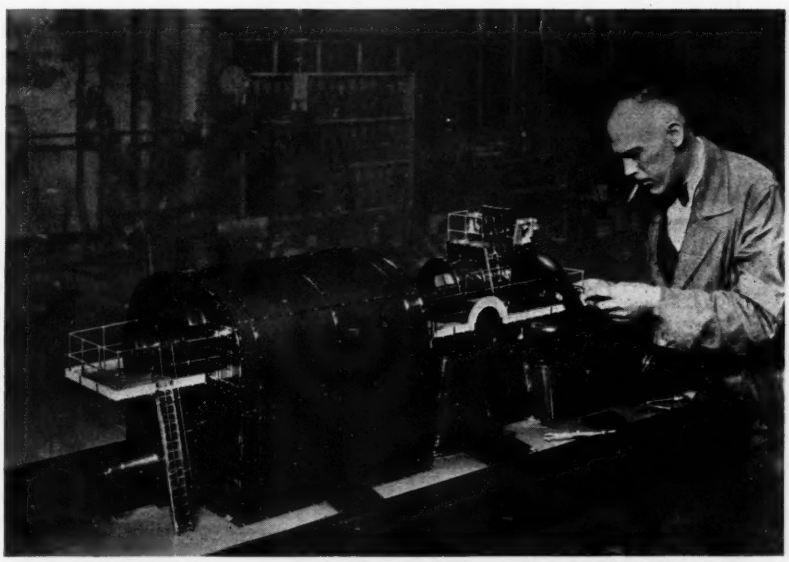
American practice has, however, shown little tendency to follow European methods and design. It is probable that American practice will be toward some adaption of Fig. 1 or 2 perhaps with a modified bent tube design for pressures of up to around 2000 lb. and an adaption of Fig. 3 for pressures up to the critical point.

Working Model *of* Ford Turbine *for* a Century *of* Progress

A WORKING MODEL of the world's largest industrial turbine-generator ever built, which has been presented to Henry Ford by the General Electric Company, builder of the original machine, will constitute a feature of the Ford Motor Company's exhibit at A Century of Progress this summer.

The model is 1/16 the linear size of the 110,000-kw. vertical compound turbine generator built at Schenectady in 1930 and now installed at the Ford Rouge plant, Detroit. It is complete in every detail, even to the turbine blades, and a cutaway section shows how it operates. The model is the work of H. E. Chesebro of the General Electric Company, whose scaled-down reproduction of an electric ship was on display at A Century of Progress last year.

The original machine is the largest vertical compound turbine ever made, and the largest turbine operating at 1200 lb. steam pressure. It had to be installed in the floor space formerly occupied by a 12,500-kw. machine, thereby constituting an unusual engineering problem, and as a result is the most compact unit ever built. The model was presented by A. R. Smith, managing engineer of the General Electric turbine department.



New Steam Generating Unit *for Continental Distilling Corp.*

New 100,000 Lb. Per Hr. Boiler in Philadelphia Distillery Installed in Limited Space in Record Time. By Carl Haner*

LONG BEFORE MAINE cast her vote for the repeal of the Eighteenth Amendment, plans were drawn by the engineers of the Continental Distilling Corp. for a large, new distillery to be built on the site of the old plant of the Publicker Commercial Alcohol Co. at Snyder Ave. in Philadelphia. With the ground dimensions limited and the time for the construction of this new plant short it was necessary to utilize as much of the old buildings and equipment as possible without sacrificing the ultimate capacity and efficiency of the new plant. A boiler plant was available containing two 330-hp., bent-tube boilers, and three 200-hp., straight-tube boilers, all fired with oil.

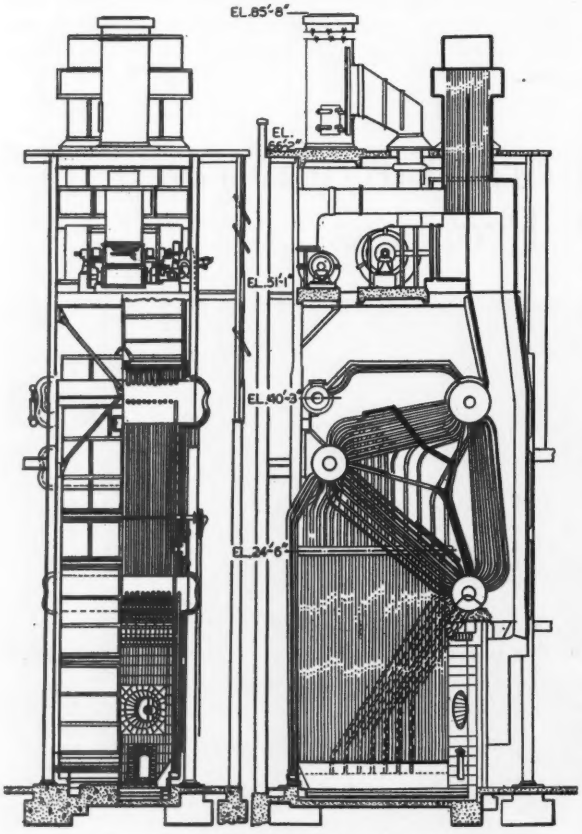
Plant heat balance studies indicated that this available steam generating capacity was insufficient and that the steam demand of the completed distillery would be approximately 100,000 lb. per hr. in excess of that which could be generated with the available boilers. The only space available in the boiler house for additional steam generating equipment was a bay, approximately 18 ft. wide by 26 ft. deep, originally intended for an additional 500-hp. boiler. This bay was utilized for the installation of a high-capacity, steam generating unit, designed for a sustained steam output of 100,000 lb. per hr.

The most serious problem was the feedwater available for the new, high capacity unit. A feedwater preparation plant was considered but had to be abandoned as no suitable space could be found so it was decided to use sodium aluminate as supplied by the National Aluminate Corp. as an internal treatment. A further safeguard against troubles with the poor feedwater available was the selection of new boiler equipment of a design which had given satisfactory service with the same poor feedwater at the Bigler St. plant of the Publicker Commercial Alcohol Co.

Decision for the proper type of boiler equipment was also influenced by the fact that the two old, 330-hp. bent-tube boilers, had given no trouble from foaming or priming. Although scale formation on the heating surfaces was at times quite heavy, tube failures were surprisingly few. These bent-tube boilers were originally placed in operation in 1918, and are still in excellent condition. The fact, of course, was recognized that the maximum rating the two 330-hp. boilers were called upon to deliver seldom exceeded 300 per cent, whereas the new, high-capacity steam generating unit would be required to perform at much higher steaming rates.

Because of the limited space available for the new unit, water-cooled furnace walls were considered to be a necessity, not only as additional heat absorbing surface, but also to permit operation with a fairly high heat release in the furnace. Again it was necessary to give careful consideration to the selection of the most suitable water wall design, always keeping in mind that the extremely poor feedwater conditions might make hazardous the operation of an unsuitable water wall system.

*Continental Distilling Corp., Philadelphia, Pa.



CROSS SECTIONS OF THE NEW BOILER

Local Experience Helpful

A number of plants were visited and a thorough investigation of available water wall designs was made. Experience obtained in plants located in the immediate vicinity of the new plant, and especially the performance of two 300,000 lb. per hr. steam generating units installed at a large sugar refinery in which substan-

tially the same kind of feedwater is being used, indicated that no trouble was to be expected from the poor water if the design of the water walls were such that a rapid and continuous circulation would be maintained at all load points.

All of the steam generated, except a very small percentage for the prime movers of auxiliaries, is used for process. High pressures and high steam temperatures were, therefore, not desirable. It was decided to construct the new steam generating unit for 262 lb. operating pressure, but to initially operate this unit at 150 lb. pressure for which the available boilers, pipe lines and prime movers were constructed.

Prime Movers Provided For

The higher construction pressure was decided upon to make it possible to install in the future new and more efficient prime movers exhausting into the present 150 lb. pressure line, if the ultimate heat balance of the plant should indicate this to be desirable. For this reason also the new unit was to be so designed that the future installation of a superheater could be conveniently made. It was further decided to design the furnace of the new unit so that it could be fired with pulverized coal if oil prices should stiffen to a degree that the use of coal would be more economical.

Turbine driven forced and induced draft fans were selected, since electrical power is being purchased and exhaust from the turbines is used for feedwater heating in a Cochrane Corp. deaerating heater. The B. F. Sturtevant Co. forced draft fan, driven by a 42-hp. Moore Steam Turbine Corp. turbine has a capacity of 31,000 c.f.m. of air at 100 deg. F. and 6.3 in. S.P. The Sturtevant induced draft fan, driven by a 90-hp. Moore turbine, has a capacity of 52,500 c.f.m. at 420 deg. F. and 7.0 in. S.P. The boiler feed pump is a 2-stage Ingersoll-Rand Co. centrifugal, driven by a Moore steam turbine.

General arrangement of steam generating unit as finally selected is illustrated in the drawing. This unit, supplied by the Riley Stoker Corp., consists of: 6680 sq. ft. of boiler heating surface; 2700 sq. ft. of water wall surface made up of 3¼ in. I.D. bare tubes on 4¼ in. centers; 6600 sq. ft. of air heater surface made up of 3¼ in. O.D. tubes. The furnace is 11 ft. 3 in. wide, 16 ft. from front to rear, 26 ft. average height and has a volume of 4765 cu. ft. Furnace side walls and rear walls are completely water cooled. Two combination pulverized coal and oil burners of the Riley Flare type design equipped with National Air-oil mechanical atomizing guns are installed below the mud drum of the boiler. Because of the comparatively narrow furnace, it was necessary to toe in the burners. It has been found under operation that this burner arrangement creates an exceedingly hot spot where the two flames combine and that there is no impingement whatever of the flame on the side walls. Regardless of the fact that the furnace is almost entirely surrounded with bare, radiant heat absorbing surfaces, it has been found that combustion is complete over the entire load range.

With the exception of the sectionally supported burner wall, there is no brick work in the furnace or boiler setting. The water walls are backed with shiplap tile, high temperature insulating blocks and an airtight steel casing. Refractories were supplied by Seaboard Refractories Co. and the high temperature insulation by Eagle-Picher Lead Co.

The gases of combustion after leaving the boiler heating surface pass through a tubular, double pass airheater. The upper part of the airheater projects above the roof of the boiler house and is insulated and weather-proofed. The waste gases are discharged through an induced draft fan and a stub stack, the stack, 5 ft. dia. by 20 ft. high, being supported on the boiler house roof.

The air for combustion is furnished by a forced draft fan placed over the top of the boiler unit, and is forced through the airheater where it is preheated to a temperature of between 250 and 300 deg. F. After leaving the airheater, the air passes down over the front of the boiler unit through an air duct built as an integral part of the boiler casing structure and externally insulated. The air is introduced through the burner openings only. Operating instruments consist of a Bailey Meter Co. steam flow-air flow meter, a Bailey three pen recording thermometer and a Bailey 5-pt. draft gage.

Construction Time Short

The entire boiler structure as well as the new monitor type of vertical building extension are carried on a common structural steel frame. It was only necessary to provide foundations for four column footings on which the entire load is placed.

With one after another of the states, casting their vote in favor of repeal during the late summer and fall of 1933, it was imperative that the new plant and the new steam generating unit be constructed with the greatest possible speed so that full capacity production could be started as soon as possible after the date on which repeal became effective. It was actually only 4 mo. from the time that the design of the new unit was decided upon that this unit was delivering steam to the process lines. This fact is remarkable, considering that during the period of erection of the new unit, considerable other construction work was going on and that space for storage and handling of materials was restricted and had to be used at the same time by the buildings and distillery equipment contractors.

Research On Anthracite At Mellon Institute

Mellon Institute of Industrial Research has announced that the multiple industrial fellowship on anthracite, established in that institution by the Philadelphia and Reading Coal and Iron Company in 1932, has been continuing, under Dr. H. J. Rose, senior fellow, its broad program of research on problems relating to the anthracite industry. So far this work has included studies of the chemical and physical properties of anthracite, new industrial uses, and economic investigations. During the past year a spectographic examination of anthracite from various seams and collieries was completed.

The staff of this fellowship has also coöperated actively with the research and engineering specialists of the donor company, in planning and conducting systematic investigations pertaining to mining and preparation problems and to domestic and industrial uses of anthracite.

Construction of L

Fig. 1 (Left). Removing the hot ingot from one of the large molds.

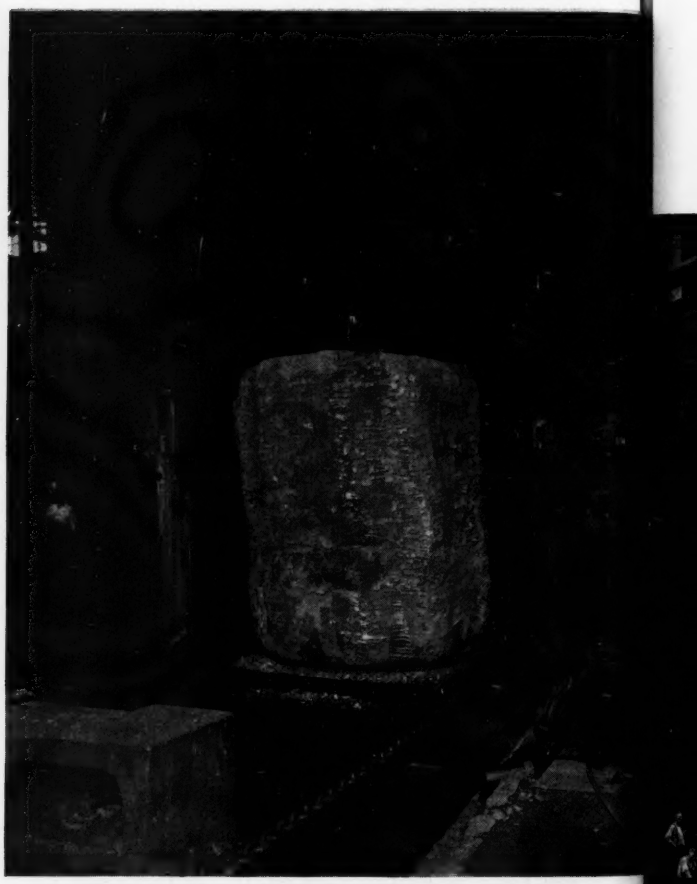


Fig. 2. Piercing an ingot to remove center after cropping the ends and upsetting.

RAPID ADVANCES have been made in recent years in the manufacture and application of high pressure steam generating units for power plants. With the development of the steam turbine and with the expansion in the size of power stations, there has come a demand for boilers with thick walls in which to generate steam at higher pressures and by which heavier loads can be carried.

Prior to about 10 yr. ago, boiler drums were made, in the majority of cases, where riveted seams to join the plates that form the boiler. About 1924 to 1925 the heavy, hollow, one-piece forged steel boiler shell was introduced, followed about two or three years ago by the all-welded steel shells.

The hollow forged drums were developed to meet increased volume requirements to generate steam at high pressures. This required greater lengths and diameters as well as adequate thickness of walls to insure strength. Some of these drums are large in diameter and of great length. The walls range in thickness from 1 in. up to 5¼ in., depending on the requirements. The maximum size is limited only by the size of the steel ingot which can be poured and handled, as well as by the design of the drum.

It is essential that the steel which is incorporated in these forged boiler drums be of the highest quality. All one-piece drums are made from a solid ingot which varies in size to suit the dimensions of the finished product. The ingot, after its removal from the mold, is reheated to the forging temperature in a furnace, after which the proper amount of discard from the bottom and the top of the ingot, which includes the sinkhead, is cut off. The ingot is then rounded up and upset or shortened. The next step is to pierce the ingot block lengthwise through the center.

Following these preliminary operations, the forging, after repeated heatings, is gradually drawn to length and enlarged on suitable mandrels under a 14,000-ton hydraulic press, until it assumes the desired length and approximate inside diameter and wall thickness. The

# of Large High Pressure Boiler Drums *from* Hollow Steel Forgings

By Edwin F. Cone

result of the forging process up to this point is a large cylinder of solid, uniform metal from the best portions of the original ingot.

All boiler drum forgings are rough machined outside and finish machined inside before necking down the ends of the drum to form the end enclosures which include the manholes. Just before this step, the rough ends are cut off and the whole cylinder or drum is subjected to careful measurement checks to insure accurate dimensions and alinement.

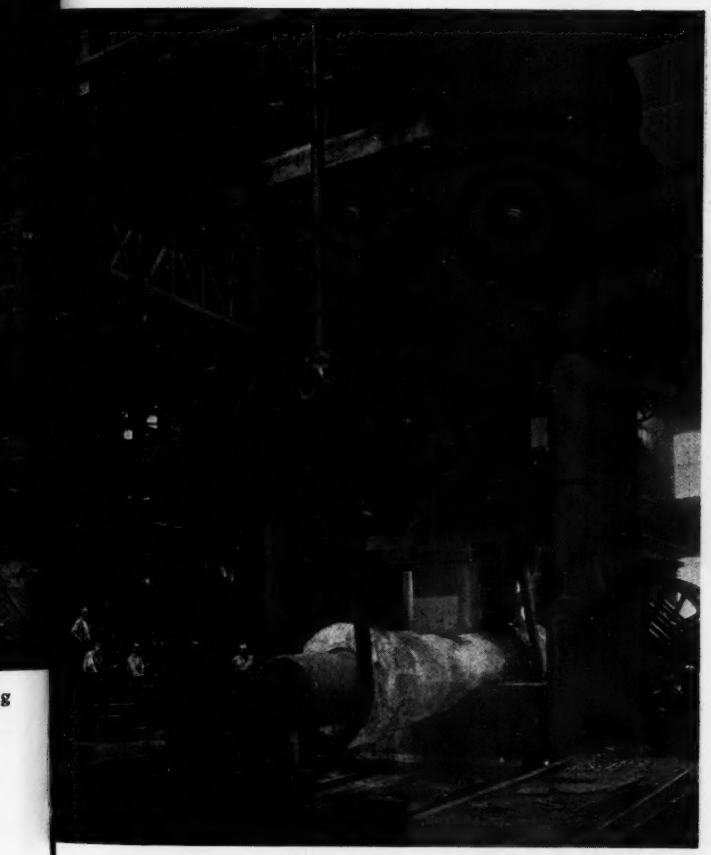
In order to bring out the highest physical properties of the steel, the forging is carefully annealed in gas-heated furnaces to remove all possible forging strains and to secure the best structure of the metal. All heating is controlled carefully by pyrometers. The necessary physical and other tests to ascertain whether the steel meets the rigid specifications of the A.S.M.E. boiler code is next in order. In general these are:

Plain carbon steel is stipulated, either acid or basic open-hearth. For Class I steel the carbon is about 0.35 per cent and in Class II it is about 0.45 per cent with the manganese 0.30 and 0.65 per cent respectively. The material must be annealed above the critical point. The physical requirements of the two classes are:

	Class I	Class II
Tensile strength, lb. per sq. in.	60,000	75,000
Yield point, lb. per sq. in.	0.5 of T.S.	0.5 of T.S.
Elongation in 2 in.—per cent	26.0	24.0
Reduction of acid—per cent	42.0	38.0
Bend, deg.	180	180

After the steel in the forging has passed the physical requirements of the specifications, the boiler drum is finish machined over the body and both ends, inside and outside, after which the two ends are sealed preparatory to hydrostatic testing. This is followed by drilling the tube holes and nozzle holes for the necessary connections. The illustrations show most of the steps described.

All hydrostatic tests are made at 50 per cent in excess of the operating pressure. If the boiler shell is



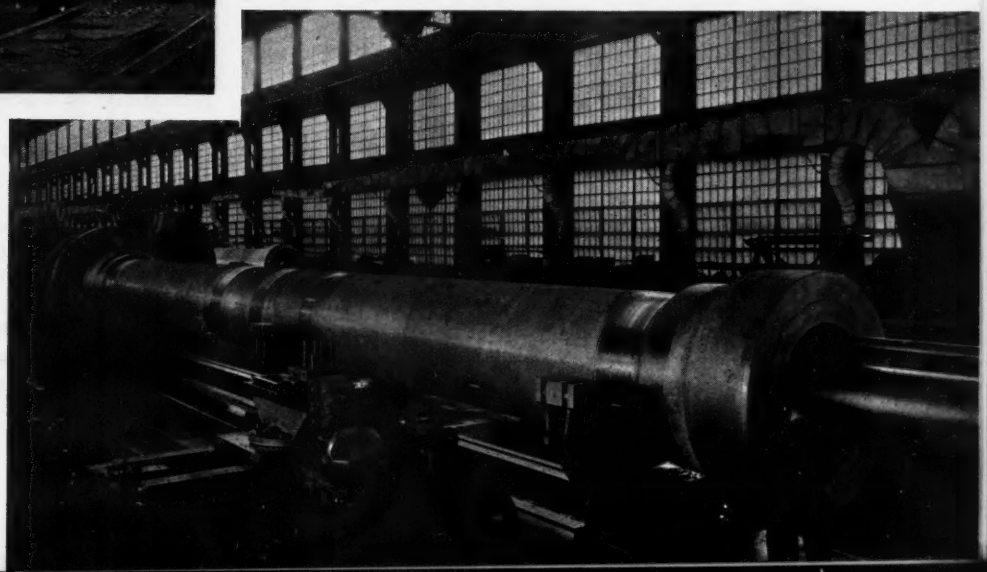


Fig. 3 (Above). Drawing the ingot, now in the form of a cylinder, to length and enlarging the diameter on a mandrel.

Fig. 4 (Right). Machining the long cylinder before closing in the ends.

to be used at 1840 lb. per sq. in. pressure, the test is made at 2800 lb. per sq. in. If the operating pressure is 1400 lb. per sq. in., the test is made at 2100 lb. per sq. in. of pressure.

Conditions under which these boiler shells must operate are severe. Some idea may be gleaned from the fact that there are boiler drums now in service, manufactured by the Bethlehem Steel Company, with an inside diameter of 52 in., wall thickness of 5¼ in.

The ingot from which these boiler drums were forged was cast in a 108-in. diameter ingot mold. The resulting steel ingot weighed 392,000 lb. After all the discards from both ends of the ingot, including other losses and scaling, the net weight of the forging was 160,800 lb. for the larger drums. The finished weight of the boiler drum was 143,717 lb. Thus the loss of metal from the ingot to the finished product was about 63 per cent.

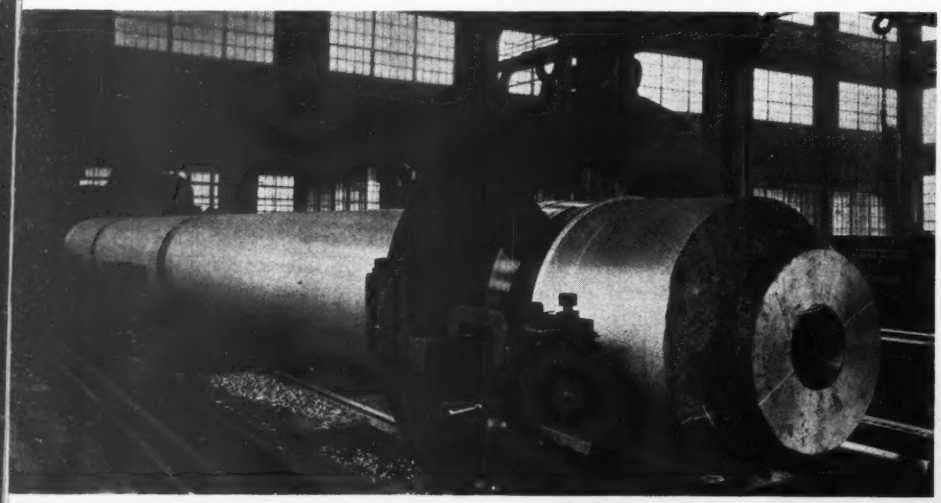


Fig. 5 (Left). Machining all the outside diameter including the ends and the inside of the ends after the forging has been necked down.

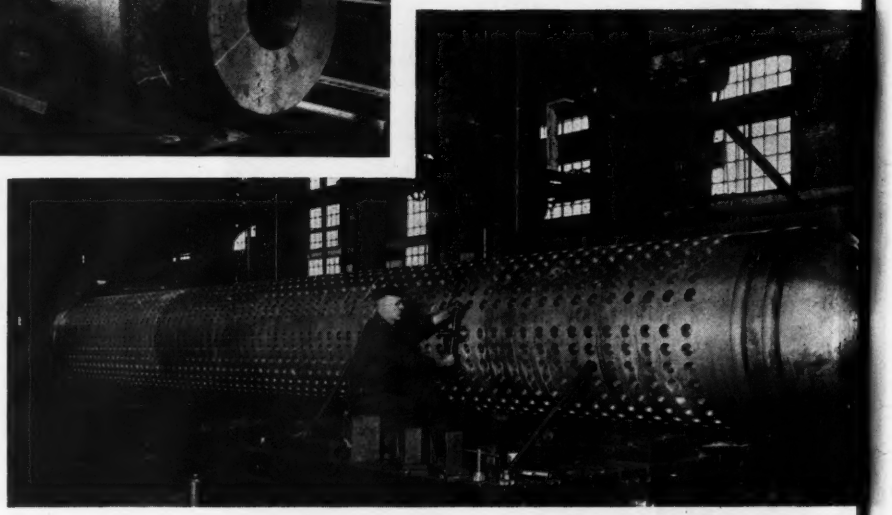


Fig. 6 (Right). The boiler drum nearing final stage of completion. Showing tube holes being reamed after hydrostatic testing. (For picture of the finished drum turn to page 352 of this issue.)

and generating steam pressures up to 1840 lb. per sq. in. At this pressure a temperature of 620 deg. F. is involved. At a pressure of 1400 lb. per sq. in., the temperature involved is 587 deg. F., at 1300 lb. per sq. in., a temperature of 577 deg. F., and so on down the list of smaller drums with varied working pressures.

Three of the longest one-piece forged steel boiler drums which have ever been manufactured were finished complete by the Bethlehem company. Two of these are 62 ft. long and one is 59 ft. 8 in. long. All three have an inside diameter of 40 in. and a wall thickness of 5¼ in., to operate at 1390 lb. per sq. in. These boiler shells are now being installed at the power plant of the Milwaukee Electric Railway & Light Company at East Port Washington, Wis. Some of the illustrations show these drums.

Thus high pressure boiler drums, made by the forging process here described, have no joints to serve as starting points for weakness of any kind, no seams where leaks may originate, walls thick enough and strong enough to guarantee the necessary safety factors, together with costs commensurate with the length of service. They contain the best portions of the original steel ingot, brought to the highest possible physical properties. A large number of these boiler drums, of varying dimensions and operating at various steam pressures, have been furnished to power plant construction companies and others during the last 10 yr. by the Bethlehem company. It is a matter of supreme satisfaction that not one has ever failed. Time and service are essential factors in evaluating the worth and dependability of a product of this nature.

DEFROSTING of refrigerator coils should be done regularly with care, according to the National Safety Council. Not only does defrosting increase the efficiency of the system but heavy frost may pull down the roof or loosen the coils, while careless defrosting may drop a heavy chunk of frost on a workman's head or rupture a pipe, or damage equipment. Storage workmen should be warned and the job carried through and completed without delay so that workmen will not enter unawares and be struck by falling pieces.

Installation *and* Maintenance *of* Intake Screens

To Maintain High Plant Efficiency, Clean Condensers Are Necessary. The First Step Toward This Is Proper Screening of Water at Intake

INTAKE WATER SCREENS are a necessary part of all power plants using any considerable amount of water. These are usually thought of in connection with condensing water intakes where it is necessary to remove the debris from the water before it enters the condenser. Originally stationary screens, either in a single line or double bank, were used for this service. They had, however, many disadvantages; labor to keep them clean was a constant item of expense and during periods of the year, usually the spring and fall, when the streams carry a large quantity of leaves and debris, it is impossible to clean them rapidly enough to prevent a severe loss of head.

This condition resulted in the development of traveling screens made up of rectangular panels of wire screen fastened to a chain and revolved constantly or intermittently by electric motors. These screens are cleaned automatically by a water spray.

Although developed primarily for water intakes, they have been widely adopted for other services. For instance, in water works and paper mills, for removing debris before filtration, for removing waste from plant water discharge and for protecting the action of regulating valves, for hydraulic cylinders on pulp wood grinders. Chemical and industrial plants, glue works and beet sugar mills have used them for screening process water either to clean the water or recover the material in suspension.

The usual screen used for condenser water service is a No. 12 B.W.G. galvanized wire with 3/8 in. square openings, although screens as fine as 80 mesh have been used for filter service. Although these screens may be operated continuously, this is seldom done except during flood periods or when the water is carrying an unusual amount of trash. They are usually operated intermittently in the average plant, perhaps turned over once each watch or three times a day. This schedule is flexible, however, and can be increased to meet local conditions.

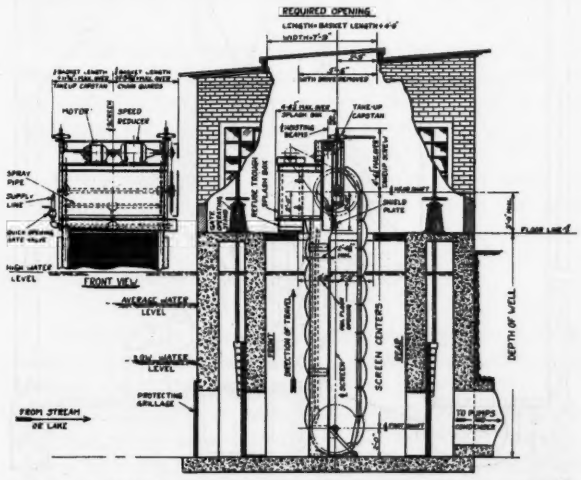


FIG. 1. A COMPLETE SCREEN HOUSE. SLUICE GATES ON EACH SIDE OF THE SCREEN ALLOWS THE PIT TO BE DRAINED FOR INSPECTION

Screens are usually designed to travel about 10 ft. per min., although in exceptional cases where it is necessary to operate continuously throughout the year a slow speed drive of 2 ft. per min. may be used instead. In some cases two-speed drive giving either 2 or 10 ft. per min. is used.

Water Velocities

In determining the size of screens to be installed for a certain capacity, velocity of flow is an important factor and must be carefully considered. While screens structurally will stand the pressure due to high velocity, some refuse and matted material will be pushed through the screen cloth. Past practice has determined that 1 to 2 ft. per sec. should be the maximum velocity through a clean screen. In rivers such as the Mississippi and Missouri which carry a high percentage of sand the velocity is preferably kept nearer the higher figure range, 1¾ to 2 ft. per sec., in order to prevent settling of sand in the boot of the screen.

Figure 1 shows a typical screen house installation complete with an outside trash rack usually made of heavy iron bars or rails either on 2 or 3 in. centers to prevent the entrance of logs and heavy sticks into the sluice gates. In this case sluice gates are provided both before and after the screen pit so that the pit may be drained for inspection or repair of screen without hoisting it from the pit, although provision is made for lifting it through openings in the roof if this should be necessary.

More detailed drawing of one screen design is shown by Fig. 2 with all parts indicated. These screens consist of a series of rectangular panels carried on strands of roller chain, the chain operating around over-head and foot sprockets. The takeup capstan, 1, is provided for adjustment of the chain tension. As the screen revolves and each panel comes on a level at the head shaft, it is cleaned by a jet of water which flushes the debris into the trough, 42.

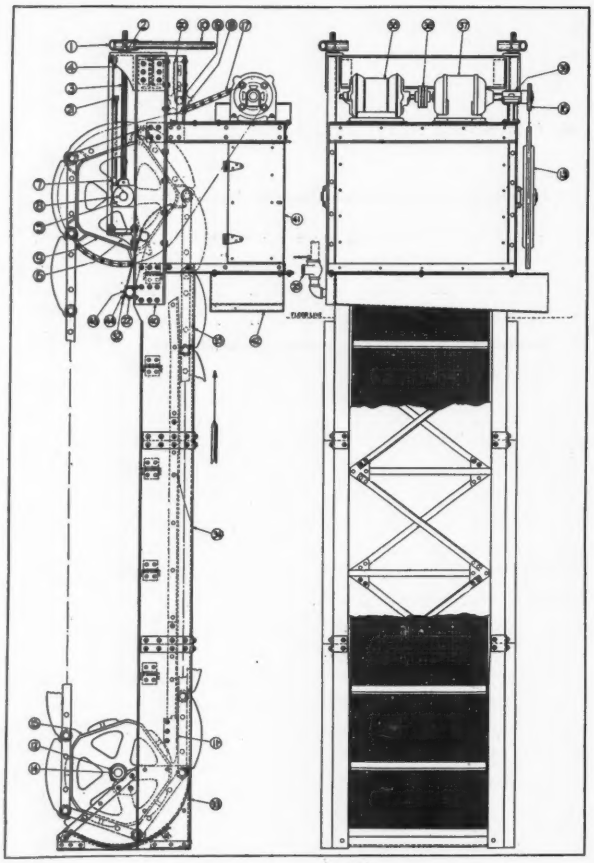


FIG. 2. DETAILS AND PARTS OF ONE TYPE TRAVELING SCREEN. 1, Takeup capstan; 2, takeup bushing; 3, takeup screw; 4, head casting; 5, head shaft bearing; 6, guide bracket; 7, grease cup; 8, head shaft; 9, head sprocket; 10, takeup lever; 11, shoe extension; 12, foot shaft bearing; 13, sprocket-driver; 14, foot shaft; 15, foot sprocket; 16, drive sprocket; 17, drive chain; 18, chain tightener sprocket; 19, chain tightener pin; 20, chain tightener plate; 21, grease cup; 22, spray pipe; 23, screen basket or panel complete; 24, wire screen only; 25, quick opening gate valve; 26, chain roller; 27, inside side bar; 28, outside side bar; 29, bushing; 30, chain pin; 31, basket attachment pin; 32, shield; 33, boot section; 34, intermediate section; 35, upper intermediate section; 36, motor; 37, speed reducer; 38, flexible coupling; 39, rigid pillow block; 40, head section; 41, splash box; 42, refuse trough; 43, U bolt for spray pipe; 44, U bolt for shield

This is known as the front spray type. In the back spray type, as shown by Fig. 3, the screen panels are not cleaned until they start downward.

The effect of screening depends upon proper sealing between the rectangular screen panels at all points, between these panels and the side and between the screens and bottom of the pit. The way in which this is done is shown by the last two drawings. Figure 4 shows the chain guard and seal and the wall guideways which guide the chain down the sides of the well. The seal plates between the panels as well as the construction and arrangement of the boot in two different types of screens are shown by Fig. 5. It is customary to support or guide the panels only as they travel upward as shown by Fig. 4. The descending or clean water side is not guided, thus eliminating the possibility of a loose chain jamming on the way up.

Maintenance

Construction of these screens is comparatively simple and very little difficulty is experienced in their assembly by the ordinary power plant maintenance crew. A general arrangement drawing is usually furnished giving the dimensions governing any particular installation or order and this is all that is needed to properly install the screen.

They are built rugged and substantial so that little skill is required in their operation and only the ordinary amount of care need be exercised to keep them in good repair. Occasional inspection should be made to determine whether excessive wear has occurred either due to a large amount of abrasive matter carried in the water or due to continuous operation occasioned by bad seasonable water conditions. Sometimes the screens are damaged by contact with heavy debris which has managed to get by the stationary bar grills at the mouth of the intake. Such damage should be repaired at once in order to get the best results from the apparatus.

The life of the traveling water screen is given by one concern as from 4 to 10 yr. under ordinary conditions, although many are operating for over 15 yr. The usual repairs are replacement of the main carrier chains which average about 10 yr. of life or the screen basket wires which have to be replaced over periods varying from 3 to 5 yr. depending upon the type of debris encountered in the water.

Pointers on Maintenance

Maintenance is of course important and is quite simple. Maintenance pointers include: Older types of screens employing chains with cotters should be inspected frequently to see that cotters have not been weakened by corrosion or by the cutting action of sand in water. Newer types with nuts and lock plates should also be inspected several times till nut has finally rusted to pin.

Rollers, pins and bushings might be checked occasionally for wear, as rusting action of water and abrasive action of silt and other foreign matter combines

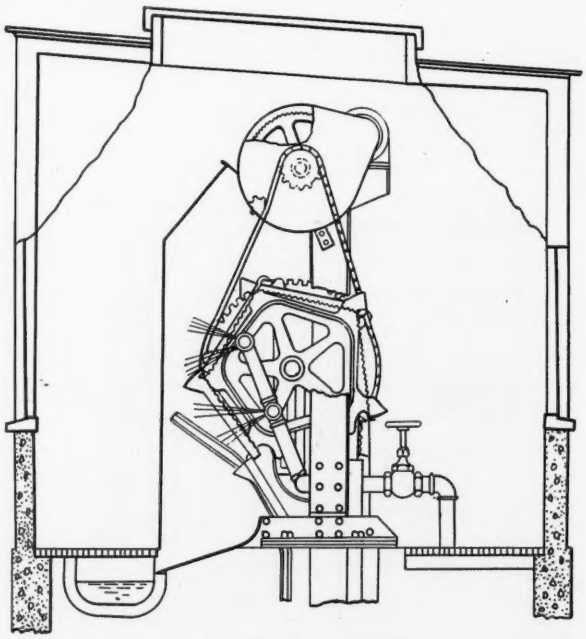


FIG. 3. DRIVING SPROCKET AND NOZZLES OF A SCREEN WITH A BACK SPRAY

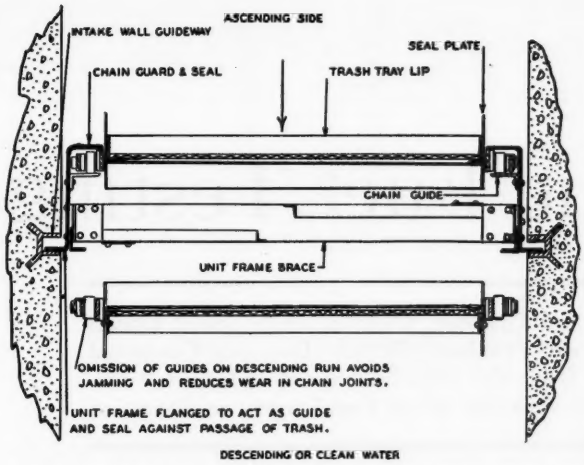

ASCENDING SIDE
INTAKE WALL GUIDEWAY
SEAL PLATE
CHAIN GUARD & SEAL
TRASH TRAY LIP
CHAIN GUIDE
UNIT FRAME BRACE
OMISSION OF GUIDES ON DESCENDING RUN AVOIDS JAMMING AND REDUCES WEAR IN CHAIN JOINTS.
UNIT FRAME FLANGED TO ACT AS GUIDE AND SEAL AGAINST PASSAGE OF TRASH.
DESCENDING OR CLEAN WATER

FIG. 4. SEALS AND GUIDES OF SCREENS MUST BE MADE SO AS TO PREVENT THE PASSAGE OF UNSCREENED WATER

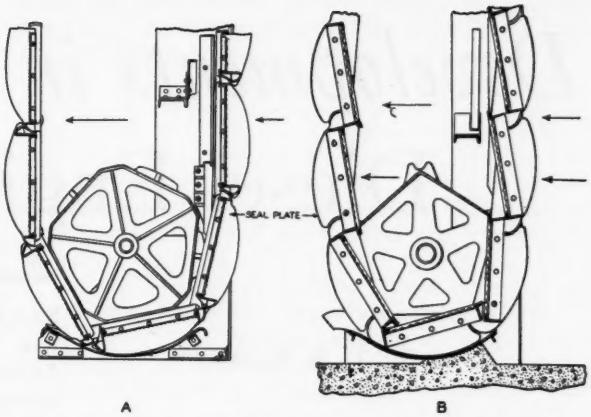


FIG. 5. TWO TYPES OF BOOT OR FOOT SECTION USED TO TIE THE FRAME TOGETHER AND PREVENT THE PASSAGE OF TRASH

to reduce life of these parts. Some larger power companies are using special stainless steel parts, hardened to resist both the corrosion and abrasion. This is particularly true of plants using screen in salt water where corrosion is excessive.

Screen Is Replaceable

Trays or baskets should be inspected at intervals to make sure that the cloth is in good condition and secure. Every nook and corner of the tray frames should be cleaned annually and painted with Bitumastic solution. This is also true of the main screen frame and is doubly important when screen operates in salt water.

Trays on the screen consist of an angle frame into which the screen cloth is laid and held in place by narrow flat bars, which are riveted or bolted through the screen wire to the angle frame. It is not necessary to purchase an entire new assembly. All that has to be done is to remove the bolts or rivets and replace the screen wire.

Sprockets should be checked for alignment occasionally and flanges carrying chain side bars inspected to be sure they are providing a true, level bearing for the links.

Unless sprays function properly the entire purpose of screen is defeated. Operator should watch performance of this part of screen very closely during each operating period. If any of the nozzles, holes, or slots are plugged, they should be cleaned immediately.

Motor and speed reducer should receive more attention than most units of that kind due to the presence of excessive moisture.

Operation

Operation is also simple and depends to a large extent upon local conditions. Operating instructions include the following items:

Open spray pipe valve before starting screen and see that good cleaning spray is available. See that spray pipe and line are not clogged and are kept clear as long as screen is operating.

Run screens at intervals sufficiently frequent to prevent a drop in water level through the screens and prevent an accumulation of mud or sand at the foot of the screen. Anticipate deluges of leaves, trash, etc., and have screens running to take the additional load.

Have screens running when starting circulating pump; when slush or needle ice is piling up on screen baskets or when dredging in front of screen house but avoid needless operation and the resulting excessive wear.

Keep trash racks clean and be sure to have screens running while cleaning trash racks. Remove all floating debris outside of intake ports.

Keep refuse drain trough free from leaves and trash accumulations. Keep a close watch on screens while in operation to note broken, bent or worn parts and loose or missing bolts.

Tighten takeups as wear takes place and carrying chains become slack. This can be observed on rear side of screen when operating. Better still, fasten narrow sheet lead strips to several basket lips, as the chain elongates these sheet lead strips will scrape on the boot plates and indicate need of taking up slack.

287,000-Volt Power Transformers

Eleven power transformers for the Boulder Dam, seven of which are rated 55,000 kv-a. at 287,000 v., the highest commercial voltage of any transformer ever built in the United States, will be manufactured at the Pittsfield, Mass., Works of the General Electric Co. under the terms of a federal contract.

Shipment of the transformers, valued at about $1,000,000, is scheduled in about a year.

The larger transformers are water-cooled, will weigh over 400,000 lb. each, and are approximately 32 ft. high, 20 ft. wide, and 13 ft. deep. The four smaller ones are rated 13,333 kv-a. at 138,000 v. and are forced-oil cooled.

Also for use at Boulder Dam, the Schenectady Works of General Electric is now building two 82,500-kv-a. generators which will be connected to 115,000-hp. waterwheels, and the Philadelphia Works is building eight superspeed impulse oil circuit breakers for the City of Los Angeles transmission lines which will break an electric circuit in five one-hundredths of a second.

Developments in Diesel Engine Fuel Testing

By T. B. Rendel[1]

Knock and Cylinder Wear in High Speed Diesels Are Two Problems Which Demand Concerted Action from the Diesel Designer and Fuel Technologist. Cylinder Wear Due Largely to Corrosion

TRENDS IN THE DEVELOPMENT of the Diesel have been toward the use of higher speeds and higher mean effective pressures with smaller cylinders. Experimental engines of 3.9 in. bore and 4.5 in. stroke have been produced to run successfully at speeds in excess of 3000 r.p.m. with mean effective pressures of the order of 86 to 90 lb. per sq. in. at these speeds.

In the author's opinion, this is logical and can be expected to continue, though the original reason for the existence of the Diesel engine must not be forgotten and the design of the engine must be such that it will burn cleanly and completely all fuels within the range between gasoline and heavy residual oils.

Many concerns are fully alive to this fact and many, if not most, makers claim that their engines can use such fuels, though some users of such engines are apt to think otherwise. Such lack of adaptability is more often than not due to a lack of intimate knowledge of the wide differences which exist between various types of fuels from different sources of supply and of the relative importance of these differences to the operation of the engines on any given fuel.

The general subject of fuel specifications is, however, too broad to be covered adequately in the space of a short paper and the author proposes to deal here only with two important factors which have recently been brought to the fore by the trend toward the higher speed solid injection type of engine. Generally speaking, the small bore high speed engines are more sensitive to the type of fuel used than their low speed cousins.

This refers particularly to those engines which, by reason of their application, have to operate over a wide speed range. The two factors which have arisen in consequence to give engineers and fuel technologists food for thought are roughness of running and a tendency to relatively high cylinder liner wear. Both are largely due to the use of fuels which are unsuitable for the engine under consideration.

Measurement of Ignition Quality

Although it is well known that the ignition quality of a Diesel fuel is dependent generally upon its chemical composition, as yet no standardized method of measuring[2] it has been developed, which will give results which are valid in terms of actual engine practice and can be generally accepted as a reproducible routine method.

In order that the work on the ignition quality of Diesel fuels might be carried out in a coöperative manner, a number of interested laboratories have recently formed a Volunteer Committee to investigate this problem. It was not the Committee's intention to encroach upon any work that is now being carried out by recognized committees of the various societies, such as the A.S.M.E. and the A.S.T.M. It was felt, however, that the delays caused by difficulties that would be encountered in obtaining necessary funds to carry out any large program of Diesel fuel research could, to some extent, be minimized by a small group of men carrying out a co-operative program of work in their own laboratories which would hasten preliminary work on important phases of co-operative Diesel fuel research.

Cylinder Liner Wear

Another source of trouble which has come to the fore with the recent development in high speed Diesel engines is excessive cylinder liner wear. Apart from those applications where the trouble is undoubtedly due to the use of dirty air or insufficient air cleaners, the trouble seems to be apparently one of corrosion. This corrosion appears to be due to incomplete combustion of the fuel, particularly under low load and low temperature conditions. Certain fuels may improve this combustion by somewhat better ignition quality or through freedom from very heavy residual components. Nevertheless, if the Diesel engine is to burn a wide range of fuels satisfactorily, the design must be such that low load, low temperature combustion is as complete as possible. This can be done by arranging for the flame to impinge on a relatively hot surface as is done for instance in some types of engines.

This problem is really one more for the engine designer than is the ignition quality problem; nevertheless, the co-operation of the fuel technologist is needed. The problem is also more acute in the high speed type of engine which is used for transport pur-

[1]Engineer in charge of Automotive Research Laboratory, Shell Petroleum Corp., St. Louis, Mo. From a paper presented before the A.S.M.E.

[2]The author devotes considerable space to reviewing these methods and explaining a new experimental engine which it is hoped can be used to give reproducible results. These methods will be reviewed later.

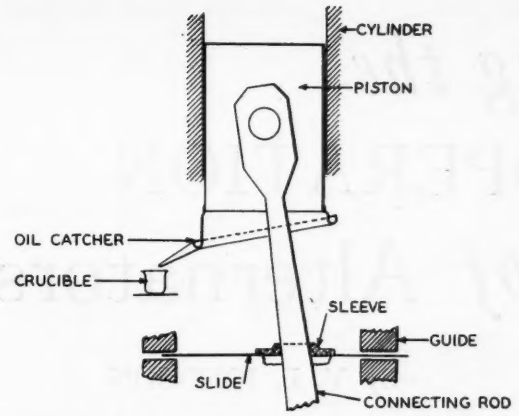


FIG. 1. OIL CATCHING APPARATUS FOR CYLINDER WEAR TESTS. WEAR IS CALCULATED BY DETERMINING THE IRON CONTENT OF THE COLLECTED OIL

poses in highway, railcar, or marine work where there is likelihood of considerable light load running under low temperature conditions.

The author would like to refer here to the theory (recently propounded by Mr. H. R. Ricardo) that cylinder wear is often the result of corrosion of the cylinder walls by the products of incomplete combustion. This theory seems to be supported by a considerable amount of data from practical experience and has gained many adherents, particularly in Europe. It will, the author believes, explain many anomalies which have occurred in high speed Diesel engine cylinder wear, particularly the concentration of wear at the top and bottom of the piston travel.

In a heavy oil engine, when the flame is chilled suddenly by contact with any relatively cold surface, the process of combustion is suddenly retarded and partially burnt products, some of them strong corrosive agents, are liberated. These half burnt products have a very acrid odor and their presence in the exhaust gas is very noticeable in a large number of high speed Diesel engines. It has been remarked that cylinder liner wear can be smelt, an opinion to which the author can heartily subscribe after sampling the exhaust odor of some of the worst offenders in this direction.

Measurement of Cylinder Liner Wear

In connection with experiments on cylinder liner wear at the laboratory of the Royal Dutch Shell in Holland a very interesting method of continuous measurement of liner wear while running is worthy of note. The conventional method for determining cylinder wear in engines is either by measuring the cylinder diameter or weighing the piston rings after long running periods. This involves appreciable losses of time for dismantling and reassembling.

Apart from this direct loss of time the method has the disadvantage in that it only shows the average wear over a long period, and abnormal wear caused by temporary insufficient lubrication, bad combustion, or overload, which is measured only after many weeks of running, may have been caused in a few hours' time by one of the disturbances mentioned. If it is assumed that by far the greater part of cylinder and piston rings wear products are carried away in the cylinder lubricants, the problem of measuring cylinder liner wear is reduced to measuring the quantity of wear products found in a given time.

This quantity is larger than would be expected, particularly on large engines, and an average cylinder wear of only 1/4000 in. in one year's running (8 hours daily) may mean as much as 100 mg. of iron per hour from the cylinder and piston rings. This quantity can be measured easily by ashing down the lubricating oil from the cylinder and determining the iron content of the ash as Fe_2O_3.

Experiments (carried out by Messrs. Boerlage and Gravesteyn) have shown that the assumption that cylinder lubricating oil carries away the majority of wear products is substantially correct and they have devised an ingenious method of measuring the cylinder wear by collecting the lubricating oil from the cylinder of a standard test engine.

Figure 1 shows the method of collecting the oil and Fig. 2 the result of tests on two different fuels showing the test fuel having considerably greater wear than the standard reference fuel, and, the effect of load on cylinder wear. In both cases it will be noted the wear is exceptionally high at the start of the test. This is in confirmation of the corrosion theory as at this time the cylinder walls would be relatively cold, resulting in high wear. The author's laboratory is carrying out a few experiments along this line in two different types of engines, but so far insufficient results are available.

Conclusion

The above two problems represent, in the author's opinion, the two most recent developments in connection with the fuel situation which have been brought about largely by the introduction of high speed Diesel engines designed to run under a very wide range of load and temperature conditions, such as are rarely met with in central power plant and marine slow speed engines.

Fundamentally, the problem is one of obtaining clean and complete combustion under all conditions. To this end the fuel should have as high an ignition value as practical considerations of economics and availability allow. If it does not have a sufficiently high ignition quality for the design of the engine a number of troubles can arise, such as high cylinder liner wear, gummy piston rings, or acrid exhaust odor. These occur through poor combustion caused by the late inflammation of the charge, since the pressure and temperature conditions, when a large portion of the charge is injected, are not sufficient to support complete combustion.

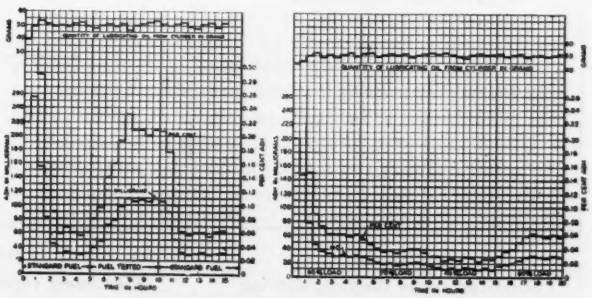
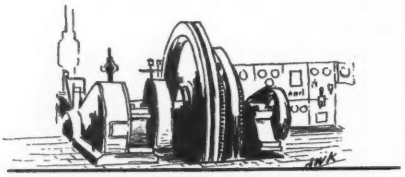


FIG. 2. INFLUENCE OF FUEL (LEFT) AND LOAD (RIGHT) ON CYLINDER WEAR

Factors Influencing the PARALLEL OPERATION *of* Alternators*



By V. E. JOHNSON

THE SHIFTING of the rotor of a synchronous generator from its no load position to other positions under various conditions of power factor and load as described in the preceding article is of little significance in a unit running by itself but when two or more alternators are required to operate in parallel it becomes a factor of prime importance. Indeed it is the cause of all the discussion that has taken place on the question of parallel operation. It is for the purpose of analyzing this action with respect to its effect upon parallel operation that this discussion is presented.

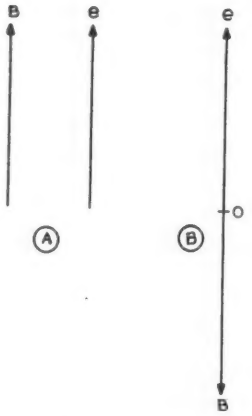


FIG. 11
Vector diagrams of two independent voltages, bus voltage, B and generator terminal voltage e.

It is evident that the terminal voltages of machines in parallel on a bus of zero impedance must be equal and in phase. They are, therefore, represented by vectors in the same relative position or, as will be shown in a later paragraph, 180 deg. displaced. That these terminal voltages are made up of several components has already been demonstrated in the illustrations Figs. 6 to 10 inclusive which appeared in the preceding article. Parallel operation then requires that these components be such as to maintain e constant in value and phase position.

The magnetic fluxes producing these voltages must also be such as to produce the needed pressure components. There are, in the final analysis, four variables involved—namely:

A—The magnitude of the rotor exciting current.
B—The angular position of the rotor.
C—The magnitude of the stator current.
D—The phase position of the stator current.

Fig. 11 (A) shows two independent vectors representing the bus voltage B and the generator terminal

*This is the second of two articles on this subject by Mr. Johnson. The first appeared on page 326 of the July issue.

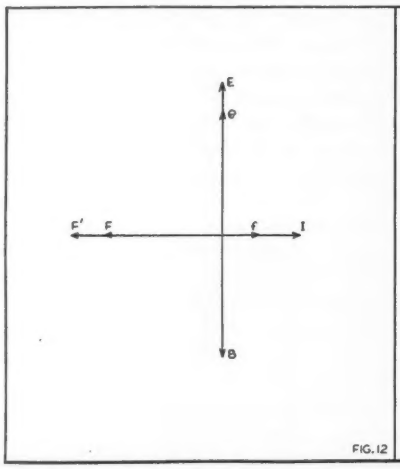


FIG. 12
Schematic vector diagram, showing effect of field increase on generators in parallel.

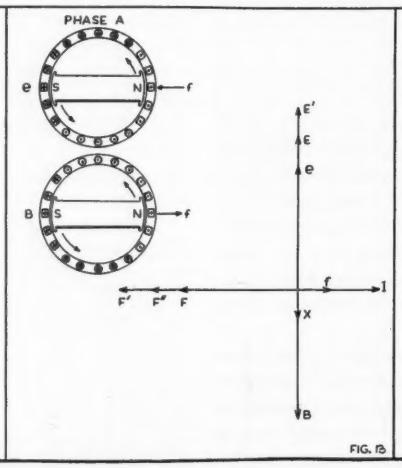


FIG. 13
Elementary vector diagram showing in more detail the schematic relations in Fig. 13.

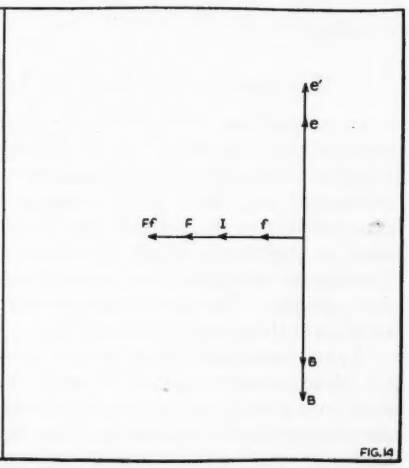


FIG. 14
Vector diagram showing how a leading current increases the generator pressure to equal that of the bus.

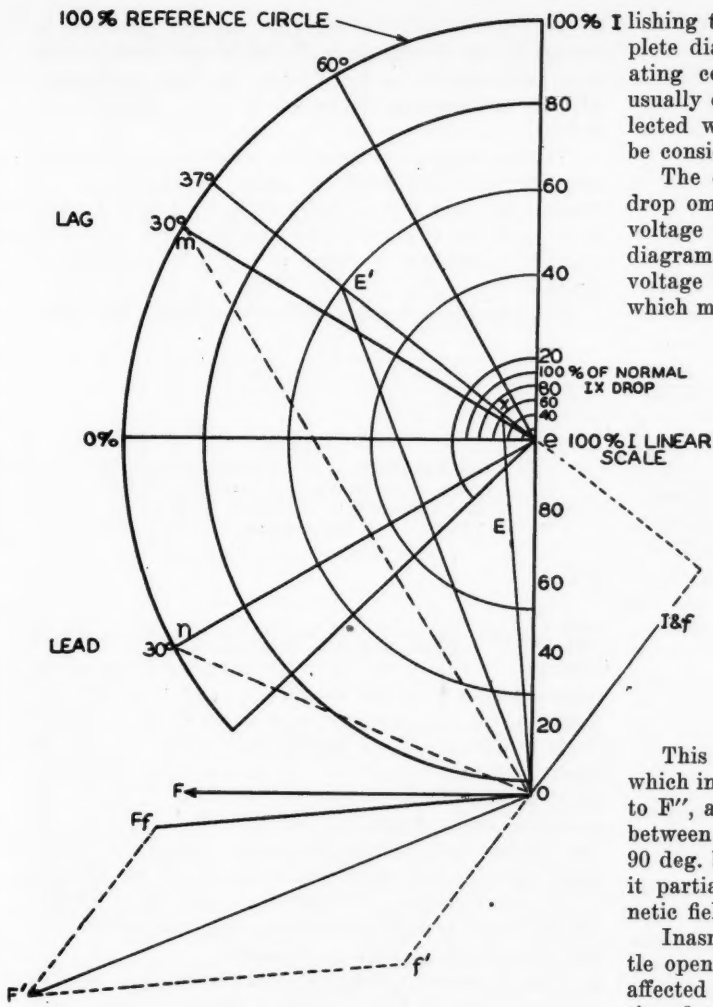


FIG. 15

General diagram showing approximately the relations that exist with a fixed current at various power factors.

voltage e. In order to combine these into a consistent vector diagram, one of them will need to be reversed so as to represent the fact that the resultant is zero. This is shown in Fig. 11 (B).

To simplify discussions of this kind, it is customary to assume that B is constant in value and angularity. Therefore o e = o B = constant value, and angle e o B is a straight angle. With this as a starting point, diagrams can be constructed based upon a variety of operating conditions.

Assume that the generator is floating on the bus and that the excitation is increased from the normal value F to F′, in Fig. 12. The internal voltage E becomes greater than B (which equals e) by the amount E e, and this must be overcome internally in order to keep the voltage on the bus constant.

Equilibrium is established as follows: The unbalanced component of pressure circulates between the machine and bus a current I, which (neglecting losses) will be in lagging quadrature with it, and therefore occupy the position shown in Fig. 12. Lumping all the stator fluxes together in one vector f, I will grow to a value where the armature reaction f just counterbalances the increase in field strength from F to F′ and consequently reduces E to the value of B.

It has been shown previously that armature reaction is not the only factor that plays a part in establishing the value of the terminal voltage, and a complete diagram has been given for a number of operating conditions. Inasmuch as the ohmic drop is usually comparatively small and can therefore be neglected without serious error, the vector analysis can be considerably simplified by omitting it entirely.

The diagram in Fig. 13 is drawn with the ohmic drop omitted. Here the normal flux F produces the voltage e, equal and opposite B, as in the previous diagrams. When F is increased to F′ the internal voltage becomes E′, thus creating an unbalance E′ e which must be overcome by the effect of the current I.

This current I sets up in phase with it the flux f, which in opposition to F′ reduces the net field strength to F″, and the internal voltage to E. The unbalance between E and e is taken up by the reactance drop x, 90 deg. behind I. Fig. 13 differs from Fig. 12 in that it partially segregates into its components the magnetic field set up by the armature current.

Inasmuch as there has been no change in the throttle opening these field manipulations have in no way affected the power output, and the machine has continued to float on the bus. This agrees with the fact that the power factor is zero.

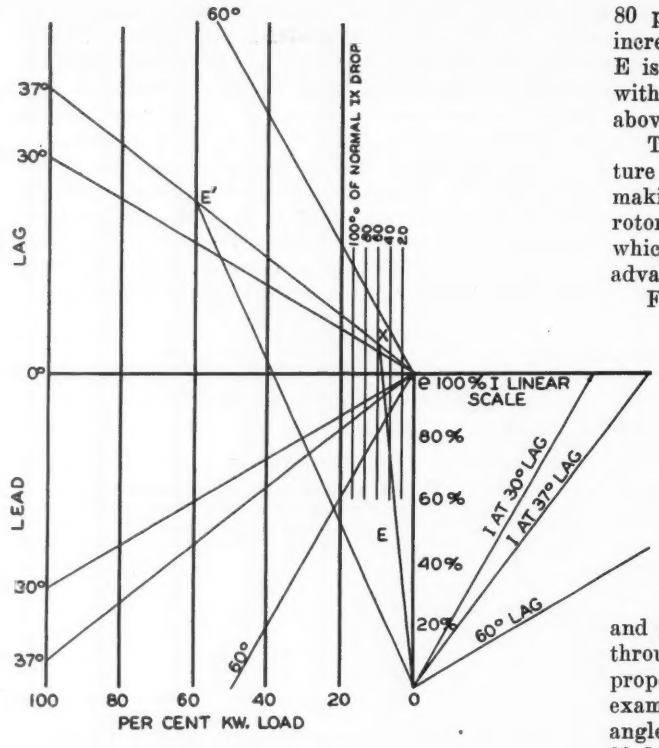
Physically, the conditions are as shown in the same figure. The maximum voltage is in phase B, but the maximum current is in phase A. The directions of current in e and B are opposite each other, because the increased voltage in e makes that machine "feed back."

The stator flux adds to the main field of B and opposes that of e. The rotor and stator fluxes in both machines are co-axial, and there is no transverse component of magnetic pull and therefore no torque. This condition of co-axiality and no torque is independent of the field strength.

An increase in the bus voltage to a new value B′ results in a vector diagram like that in Fig. 14. The current I now leads e by 90 deg., so that the flux f is added to F to form the equivalent magnetism F f. This increases the machine pressure to e′ equal to B, and so re-establishes equilibrium.

A general diagram showing approximately the relations that exist with a fixed current at various power factors is shown in Fig. 15. Certain simplifying assumptions have been made in constructing this figure, to wit:

A. The resistance drop is omitted.
B. The saturation curve of the machine is taken as a straight line.



C. The scales are chosen so that a voltage and the flux that produces it are represented by vectors of equal length.

D. The figure is not intended as a graphic solution for a specific problem, but is drawn merely to show in a qualitative way the phenomena that occur when the field is varied and the stator current is held constant.

The vector construction for one operating condition is drawn in order to show how the general figure is arrived at. All other points can be obtained in the same manner.

The vector e, as in the previous figures, represents the terminal pressure that must be maintained in order to stay on the bus. The scale o e is also used as a measure of the linear magnitude of the current I, and is marked off in per cent of rating. The small arcs about e as a center have as radii the reactive drops corresponding to the loads indicated.

Assuming then as the example a 60 per cent load at 80 per cent power factor, lagging. The current vector is the line o I displaced from o e by an angle of 37 deg. (80 per cent P.F.) laid off in the clockwise direction, and 60 per cent in length as measured on the vertical scale. By the proper choice of scale, this line o I can represent the magnitude of the flux, and as the magnetism and current are in phase it becomes as well the flux vector o f.

The radius e—37 deg. is at right angles to o I (extended), and the radius e x corresponds to the reactive drop at the 60 per cent current value. The vector E made up of o e and e x represents in value and phase position the voltage necessary to maintain e at the required constant value.

In other words, the maintenance of a constant terminal voltage requires that at 60 per cent load and 80 per cent power factor, the internal pressure be increased and displaced to E. With the scale chosen E is generated by a flux F f in leading quadrature with it, and having a length o x (see assumption C above).

To compensate for the distorting effect of the armature flux f a component f′ must be added to F f, making the main flux actually F′ instead of F f. The rotor position is represented then by the vector E′ which incidentally is equal to o F′. The angle of advance is e o E′.

For any other current and power factor, the value and position of E′ can be found at once by drawing through o a line to intersect the crossing point of the proper radius and arc about the point e. Thus, for example, for 100 per cent current at 30 deg. lag the angle of advance is e o m and the main flux o m. At 30 deg. lead the angle is e o n, and o n the main flux.

FIG. 16
General diagram of the same character as that in Fig. 15 except that it is based upon a constant kilowatt load instead of upon a constant current.

It is interesting to note that the field strength controls the angle of advance and the power factor, but that it does not control the power output. Furthermore with the constants used, only about 80 per cent of the rated current will flow when the field is opened. At this point armature reaction alone will produce the flux needed to maintain e constant.

Fig. 16 shows a diagram constructed in a manner similar to that in Fig. 15 except that it is based upon a constant kilowatt load, instead of upon a constant current. The arcs are replaced by straight lines parallel to the axis e. The condition for any load and power factor can be found directly without vector construction.

Thus at 60 per cent load at 80 per cent P.F. lag (37 deg. lag) the reactive drop is e x so that an internal voltage E must be generated to maintain e constant. This requires a field strength o E′ with an angle advance e o E′.

Fig. 16 being constructed on the same assumptions as Fig. 15, the ohmic drop and consequently the losses are neglected. This makes the generator output equal the engine input. The angle e o E′ increases when o E is reduced, the point E′ moving along the vertical line corresponding to the load. The minimum excitation that will carry the load is theoretically that which produces a 90 deg. lag for a smooth core rotor.

From the foregoing discussion it is evident that the excitation controls the stator current within wide limits both as to magnitude and phase position.

Load Control

As the throttle on the prime mover is opened wider, the rotor advances from its position of co-axiality between the rotor and stator fluxes. At once, a component of the rotor magnetism cuts the stator con-

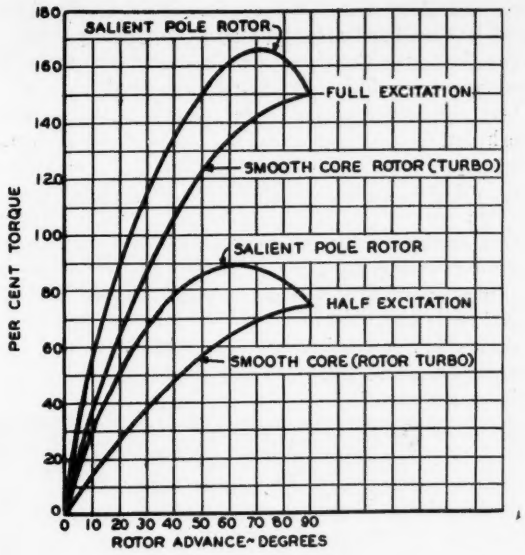


FIG. 17
Typical curves showing relation between torque and the rotor displacements for various excitations.

ductors and produces a torque which opposes the rotation of the unit. The angle of advance increases until equilibrium is again established.

The magnitude of the angle through which the rotor advances is for any given load determined by the magnetic flux, or in other words, by the excitation.

Fig. 17 gives a set of typical curves showing the relation between the torque and the rotor displacement for various excitations. The smooth rotor machine (turbo generator for example) has its pull out torque theoretically at 90 deg. displacement, for if the advance increases still further than that the torque decreases. For a salient pole machine the maximum torque occurs with a smaller angle.

Special Problems

There are certain electrical linkages in which field manipulation affects the load. One of these, a rather unusual one, is the case of a unit consisting of two generators mounted rigidly on the same shaft, and operated in parallel on the bus. The rotors are not free to assume positions of equilibrium, so that the load can be shifted between the machines by adjusting the excitation. The power output of the whole set is unaffected.

Another, and more common, example is that of synchronous frequency changer sets operating in parallel on both ends. Here, as in the previous example, the rotors are not free to assume positions of equilibrium, although the restraint is not entirely rigid.

The load shifting accomplished in such sets by means of field manipulation is accompanied by changes in power factor which are often undesirable. Consequently the desired division is accomplished by physically shifting the stators in cradles mounted on the bed plates and arranged for that purpose.

In the absence of these cradles, some adjustment can be made by shifting the shims under the stator feet from one side to the other in such a fashion that the frame in effect rotates in the right direction to secure the desired balance.

(1) The manipulation of the field has, except in special cases, no effect on the division of power load between generators operating in parallel.

(2) The manipulation of the field affects the magnitude and phase position of the stator currents.

(3) There is a relation between the angular rotor displacement and the excitation, the displacement becoming smaller as the field is strengthened.

(4) As a result, increasing the field increases the pull out torque.

Welded Specifications

At the Washington meeting of the ASTM in March, Committee A-1 on Steel was active on welded pipe problems. Four specifications, covering fabricated pipe, including electric-resistance welded, forge-welded, lock-bar, and riveted steel pipe, are to be submitted to letter ballot of all A-1 members for recommended adoption as standard. A change in the electric-fusion-welded steel pipe specifications A139-32T was proposed involving the projection of weld metal. Instead of a requirement that it shall not project more than 30 per cent for pipe 3/8 in. in thickness or under, and 25 per cent for pipe over that thickness, the requirement will be revised to read as follows: "The weld metal shall not project more than 50 per cent of the wall thickness for pipe 3/16 in. in thickness or under; not over 30 per cent for pipe over 3/16 in. up to and including 3/8 in.; and not over 25 per cent for walls over 3/8 in."

New specifications for electric-fusion-welded steel pipe 18 in. in diameter and over, for high-temperature and high-pressure service were approved by the committee for submission to the Society. Supplementary requirements of an optional nature are provided for pipe intended for use in central stations having steam service pressures of 400 lb. per sq. in. or over and temperatures up to 850 deg. F. Three grades of plate for use in making the pipe are given, minimum tensile strengths being 45,000, 50,000 and 55,000 lb. per sq. in. Radiographic examinations of the pipe are required. Each length of pipe is to be tested to a hydrostatic pressure which represents a stress of 75 per cent of the minimum specified yield point.

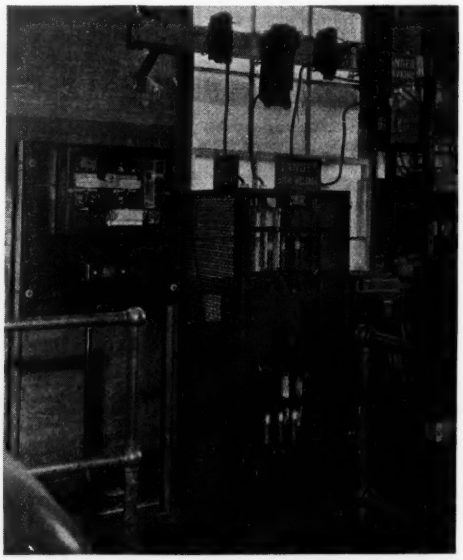
Canvas bags introduced recently for the delivery of ice have proved most satisfactory from the standpoint of eliminating hazards and improving sales conditions, according to a survey conducted by the National Safety Council. Not only do these bags insure cleaner delivery, prevent dripping of water and chips of ice on floors, but they have proved popular with the deliverymen, making the handling easier and keeping the men's uniforms dry.

One reply stated that after trying practically every type of bag they found the heavy canvas bag of 75 lb. capacity with a rubber bottom with 4 in. rubber sides to be the best. The rubber bottom is more durable, leak-proof and does not mar the floors. Bags with fibre bottoms and sharp corners and those with metal bottoms or supports are apt to cause injury to the floor, furniture or ice box finish.

Capacitors Effect Great Savings *in* Industrial Plants

WHILE IT IS GENERALLY known that capacitors or static condensers as they used to be called can be used to distinct advantage in improving low power factor condition, their real importance is usually not appreciated until one analyzes actual conditions. The two examples referred to here indicate how effectively these devices fit into the "picture" of the average industrial plant electrical layout, and to what extent they can save money.

The Wyandotte Worsted Co. of Pittsfield, Mass., generates its own power with a 500-kw., 3-phase, 230-v. turbine generator unit having a full load current rating of 1500 amp. Faced with the realization that the plant load was running up to approximately 400 to 500 kw. at a power factor varying between 65 and 70 per cent, and that the peak current, therefore, rose to approximately 1700 amp., considerably over the full-load rating of the turbine generator, the company chose the most economical method of correcting the difficulty and purchased a 240-kv-a., 4000-v. General Electric capacitor.



Left. 60-kv-a., 2300-v., 60-cycle, 2-phase rack type capacitor installed in plant of the Eaton Paper Co., Pittsfield, Mass.

Right. Large rack capacitor, 240-kv-a., 4000 v., 60 cycles, 3-phase in plant of Wyandotte Worsted Co., Pittsfield, Mass.

The current was reduced from 1700 to 1300 amp. while the power factor was increased from 67 to 88 per cent. As a result of voltage improvement, conditions on the exciter were also improved. This textile plant can now add more motors to its circuits without overloading the turbine-generator.

In another instance, at the plant of the Eaton Paper Co. of Pittsfield, Mass., by installing a small General Electric rack type capacitor rated at 60 kv-a., 2 phase, 60 cycles, 2300 v., a 76 per cent return on the investment was realized after deducting operating costs, depreciation, etc. Considered over a ten year period this investment of $525 will return over $4000.

By the terms of its power contract, this company was billed for the year according to the greatest monthly demand recorded. The monthly demand was approximately 134 kv-a. at a power factor of 72.7 per cent.

Generating most of its own power from a reciprocating engine, and using the exhaust steam for heating purposes, this company purchases very little power in the winter time and was required to pay the high monthly demand recorded during the summer months. A survey indicated that a 60-kv-a. capacitor would save about $400 annually.

Retirement Provision

IN ITS BULLETIN No. 555, for April, 1934, the American Trade Council, 744 Jackson Place, Washington, D. C., has summarized its findings with regard to homes for those who wish to retire at the age of 65 or later which are available throughout the country on payment of a moderate amount to the home. These are not state institutions but endowed, where the payment of a definite sum provides a home during the balance of the resident's life. The provision is for those who are beyond the active working period and who wish to make definite arrangements for spending quietly the later years of life in comfortable surroundings and without the restrictions which ordinarily surround government or organization homes. Some 25 institutions are described, with varying cost of entrance, distributed throughout the country. The Council offers its services and good offices to any who may be interested in this matter of provision for the declining years of life.

SALES TAX forms for Michigan will be mailed to all taxpayers Aug. 1, in booklet form. Sales tax license is issued to former taxpayers on receipt of their July return. New taxpayers must file a special form to be obtained from the Tax Administration at Lansing or Detroit.

Dual Ventilation Aids Totally Enclosed *Motors*

TOTALLY ENCLOSED motors, such as used in dusty, damp or hazardous locations, for years were much bigger and more costly for their power than ordinary open motors because of difficulty in cooling them. Recently, Westinghouse engineers perfected an ingenious scheme of ventilation which makes possible enclosed motors up to 200 hp. with mounting dimensions comparable to open types. Internal and external air is circulated by fans through paths which cause

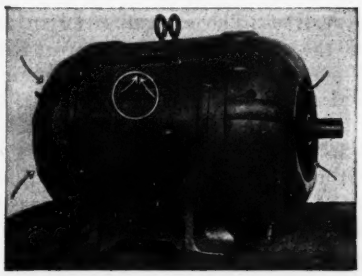


FIG. 1. THIS TOTALLY ENCLOSED MOTOR HAS TWO SETS OF FANS. An outside set which blows external cooling air through a series of parallel ducts in the frame casting, and an inner one which circulates hot internal air through alternate internal ducts; in this way the rotor heat is transferred to surfaces in contact with the cooling air

rapid transfer of heat from the internal air to the frame and from the frame to the external air.

The frame contains two sets of ducts. The first set runs from one end of the frame to the other, inside the motor. The internal ventilating air is drawn by the internal fan through the air gap and rotor core vent holes,

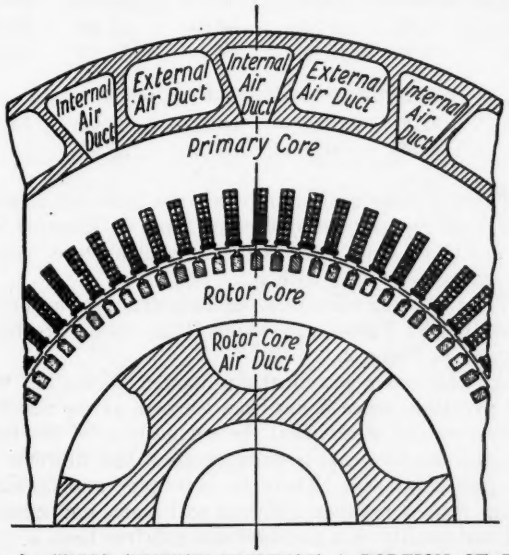


FIG. 2. CROSS SECTION THROUGH A PORTION OF THE MOTOR FRAME SHOWING THE PATH OF THE INTERNAL AND EXTERNAL AIR

and is driven through the stator and turns and through the internal ducts over the stator core. When the motor is assembled the internal air is effectively sealed within the motor. The second set of ducts alternate with the first and pass from each end to the center of the motor. Double end ventilation is used on the larger machines. Since the ducts carry external air in close proximity to the internal air there is a heat exchanger effect. The interior fan on the rotor of the motor causes a continuous internal flow of air so that there are no dead air spaces and heat is continuously carried away from the electrical parts.

These motors are suitable for refineries, for agitators, hot oil pumps, gasoline pumps, centrifuges, gas boosters and other class I group D hazardous locations. The expense of fire walls can be saved—steam engines with their long steam mains are not required. They may be used outdoors if desired as they are fully protected from the weather.

MANY IMPROVEMENTS are being made to reduce the fire hazards of turbines. The piping arrangement is given careful attention both as to arrangement and details, hot steel surfaces are carefully covered up and drip pans are introduced to direct the flow of oil from certain probable sources. In some installations, the oil tanks are placed in a fireproof housing at some distance from the turbine, and in others the tanks have been equipped with arrangements for quick drain in case of fire.

The close proximity of hot steam parts and combustible oil in the valve operating gear is undoubtedly one of the greatest fire hazards in the modern high temperature installations. Whether the valves are placed on top of the cylinders or in separate steam chests at the side of the cylinder does not seem to be of fundamental significance, because serious oil fires have occurred on both types of arrangements. The former arrangement may probably contribute to more extensive damage of the turbine parts.

In endeavoring to find an arrangement which will fundamentally reduce the fire hazard, a great many schemes have been proposed. Valve operation by mechanical linkages from operating pistons, located at appreciable distances from the valves, is always a possibility, but the resulting complications in certain types of turbines are objectionable.

The most attractive solution is a non-combustible lubricating medium. There are already compounds on the market for which satisfactory lubricating properties are claimed, but it is too early as yet to tell whether these claims can be substantiated. The elaborate requirements at present placed upon lubricating oil would seem to make the finding of a synthetic non-combustible compound nothing short of a miracle. Pending the final outcome of this work, it is possible to separate the governing and lubricating systems. Many liquids may be used as governing fluid, since the requirements are so much simpler. Water may eventually become possible, although the corrosion problems are somewhat difficult to anticipate. At the present time, there are a few turbines in operation in which Aroclor, a synthetic non-combustible lubricant, is used as a governing fluid in this manner.—C. R. Soderberg, W. E. & M. Co., before the N.A.P.E.

Simplified Check *for* Heat Value of Coal

By A. Bement

IN THE TRANSACTION between coal producer and consumer, B.t.u. per pound of moist coal is the most important measurement to determine value. Practically all coal, shipped by rail or otherwise, is billed to the customer at the mine weight as loaded and then becomes the property of the purchaser; change that may occur to the shipment is at the buyer's risk.

Moisture Variation Matters Little

During the shipment, the only change that occurs to quality applies to the moisture content. In dry, warm weather moisture decreases. In the winter or during wet weather it increases. Extended experience of utility companies using such coal as that of Illinois shows that moisture varies by one per cent, plus or minus, and that over the year the average at destination is practically the same as when the coal was loaded at mine. Thus a given 50-ton car may arrive 1,000 lb. either over or under weight.

If coal arrives with excess moisture, the heat value of the shipment per pound is proportionally affected but the total quantity of heat-producing material in the shipment is unchanged. Likewise, reduction of moisture increases the heat per pound, but does not add to the total heat content of the shipment. In one case, the shipment as received at destination is over weight, which is no advantage to the coal user, because the extra weight is only water. Likewise, there is no loss to the purchaser, if coal arrives under weight due to its becoming drier during shipment.

Ash Only Dilutes the Fuel

Percentages of moisture, ash and B.t.u. per pound, on a commercial basis, have largely occupied the center of the stage as a measure of coal quality. It is, however, to our advantage to examine the matter further. If coal be defined as a material that produces heat in combustion, it must be conceded that moisture and ash are not coal in this sense, but rather are impurities associated with coal in what might be termed the fuel mixture. Now the ash and moisture-free fuel is also composed of different elements that are both heat and non-heat producing, the amount present of any one of these various items affecting the quantity of others in the coal mixture. For example, high ash tends to depress B.t.u. per pound as delivered and we are prone to consider the coal as inferior in heat value, when it is rather a matter of high ash. It is, therefore, apparent that a comprehensive basis on which to compare analytical data is essential in dealing with the results of coal analyses.

Percentages of constituents as determined by analysis are affected by the amount of other associated items as above mentioned. For example, in Table 1, sample A appears to have higher B.t.u. value as received than sample B. When, however, the values are calculated to a moisture and ash-free basis, it appears that the lower heat value of sample B on the commercial basis is due to higher ash; that the basic B.t.u. value in the combustible is the same for each and that the difference is one of ash instead of B.t.u.

Not only do amounts of moisture and ash affect the commercial B.t.u. value, but also amounts of other constituents, such as fixed carbon, volatile matter and sulphur as derived in the proximate analysis.

Table 2 presents an ultimate analysis of a typical coal, from which it appears that heat production is had from constituents of Group 1. Those of Group 2, while non-heat producing, are so closely associated with the constituents of Group 1 that they are measured only as the result of an ultimate analysis, while the constituents of Group 3, ash and moisture, are easily determined and are always given in a proximate analysis.

It is from Group 1 that all of the heat produced by the coal is derived. The carbon given in the table is the total in the coal, while in the proximate form of analysis a portion appears in combination with the available hydrogen as hydro-carbons, which with a portion of the sulphur produces the combustible gases that, together with the chemical water, form the total volatile.

While Group 2 consists of non-combustible elements, its relation to Group 1 is such that, in a feasible conception of coal structure, both groups must be considered in combination as a unit, because of the chemical relations of the groups. For example, oxygen, a non-combustible, cannot exist as such in the coal structure but is in combination with a portion of the hydrogen equal to one-eighth of the oxygen, in the form of chemical water. Thus, that portion of the hydrogen available for heat production appears in Group No. 1, while the remainder is in Group No. 2 as a non-combustible.

Table 1. Effect of Ash on Heat Value of Coal

Sample	Percentages by Weight — Moisture	Ash	Fixed C.	Volatile	B.t.u. per lb.
	Commercial Basis as Received				
A	5.00	7.50	56.04	31.46	12,928
B	5.00	10.00	54.44	30.56	11,818
	Moisture and Ash Free Basis				
A	0.00	0.00	64.05	35.95	14,772
B	0.00	0.00	64.05	35.95	14,772

From a structural standpoint, the total constituents of coal are represented by Groups 1 and 2. Moisture and ash are in no sense constituents of coal but are, rather, impurities associated with it.

The foregoing conception of fuel structure is further illustrated by Table 3, in which B.t.u. values are based on those in Table 2.

All this has a practical application in dealing with coal problems, since it has been learned, as the result of experience and study, that the composition of the moisture and ash-free coal is quite constant and uniform for any particular coal. There is, of course, a wide range in this respect between different coal seams and kinds of coal, but quality on a moisture and ash-free basis is often so uniform for a given coal seam, or for a defined area of a seam, that the difference between mines therein, as

far as heat values is concerned, is less than the error inherent in the laboratory process of measuring them. In view of this, if the basic moisture and ash-free values are known, together with a simple moisture and ash determination, data are afforded for the calculation of the heat value or proximate analysis for any shipment from a known seam or locality. And also as the moisture content, like the B.t.u. quality, is a constant for any such defined area, an ash determination may be the only laboratory result required to enable heat value to be figured in case of coal bought at mine, the mine moisture value being applied to the shipment and used in the calculation.

Knowledge of these basic values for a particular coal is of special service in detecting errors in case of laboratory reports or in sampling, and of extravagant claims of quality, also in simplification of testing. Quite often, coal from a regular known source is continually put through the laboratory for heat value and proximate composition when, as a matter of fact, an ash determination may be all the laboratory work that should be necessary.

Usefulness of values on a dry basis is limited to ash. No company produces, nor does a consumer buy dry coal. The combustion process, however, deals with dry coal. In the furnace the moisture is expelled, with the result that ash percentage of the remainder increases in proportion. For example, with moisture and ash each 10 per cent for the coal as fired, as the moisture is driven off at once by the heat of the furnace, the ash that affects furnace operation becomes 11 per cent of the remainder instead of 10 per cent.

TABLE 2. COAL COMPOSITION AND CORRESPONDING HEAT VALUES DERIVED FROM CONSTITUENTS OF 1 LB. OF COAL

Group	Constituent	Percentage	B.t.u. per lb.
	Carbon	72.10	10,454
1	Hydrogen	3.90	2,418
	Sulphur	1.25	56
2	Chemical Water	9.00	None
	Nitrogen	1.25	None
3	Ash	7.50	None
	Moisture	5.00	None
	Total	100.00	12,928

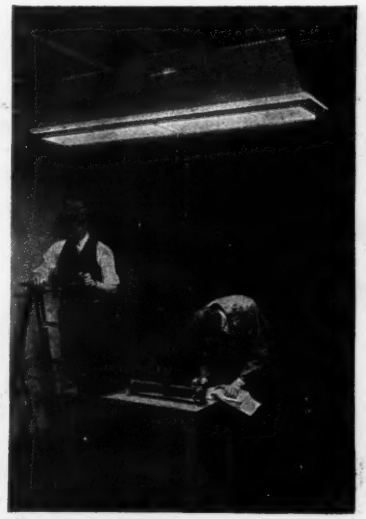
TABLE 3. HEAT VALUES FOR DIFFERENT BASES, DERIVED FROM TABLE 2

Constituents Considered	Status of Fuel	B.t.u. per lb. of Fuel	Per Cent of Heat-Producing Material in Fuel
Carbon Hydrogen Sulphur	Pure Combustible	16,735	100.00
Combustibles Chemical Water Nitrogen	Moisture and Ash Free Coal	14,772	89.75
Combustible Chemical Water Nitrogen Ash	Dry Coal	13,601	82.25
Dry Coal Free Moisture	Commercial Coal as Received	12,928	77.25

High Pressure Mercury Lamps at Ford Exhibit

SCIENTIFIC SEARCH for artificial illumination equal in quality to natural daylight has resulted in a new light source, the high-pressure mercury vapor lamp, which will, in combination with incandescent electric lamps, provide illumination with all the elements of normal daylight. Westinghouse engineers are using this new development for the first time for the lighting of the Ford Motor Company's Exposition Building at a Century of Progress in Chicago.

More than 500 of these new lamps are used in the Ford Building. Each lamp consists of a long tubular bulb from which the light is intensely brilliant and greenish-blue in color. Its characteristics are quite different from the lamps that have used mercury vapor heretofore, as, due to the high temperature and pressure, the color is much closer to that of the blue sky. In addition, these lamps produce more than twice as much light for the same power consumption than previously available similar types, each providing 50 lumens of light per watt, whereas the ordinary incandescent lamp produces not much more than 20 lumens per watt.



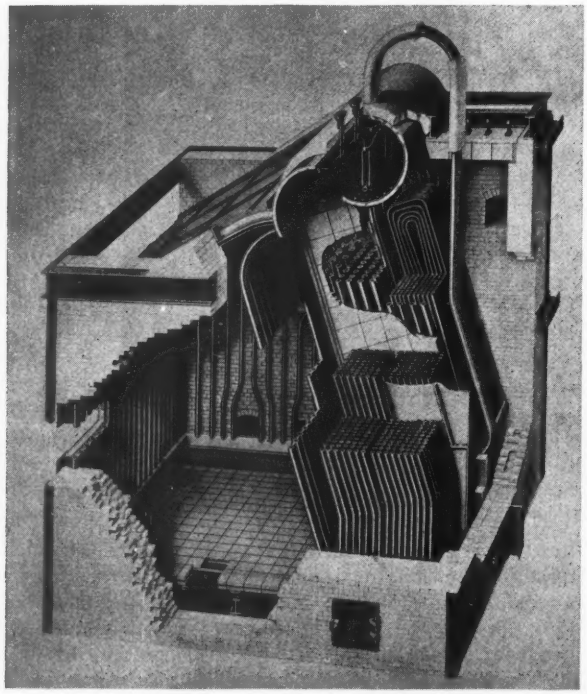
The new lamps are used in combination with modern Mazda lamps in order to obtain the color elements found in natural daylight. For that reason, combination reflectors have been developed. These are of two types, one a trough type unit containing two 400-watt high-pressure mercury vapor lamps and three 500-watt incandescent lamps; the other a cylindrical unit containing one 400-watt mercury lamp and six 100-watt Mazda lamps. The units also required the development of special transformers.

The light produced by the new mercury lamps appears greenish-blue in color and lacks the red and yellow rays, while the light of Mazda lamps appears yellowish-white because it contains an overabundance of red and yellow rays and is relatively weak in green and blue rays. Combining the two types of lamps, therefore, in one reflector provides a perfect unit as their light can be blended in the proper proportion to approach true white light which contains equal proportions of all colors.

Integral Furnace Boiler

DESIGNED to provide a completely coördinated unit comprising a two-drum boiler, a water-cooled furnace, burners for liquid, gaseous, or pulverized solid fuels, and, when needed, a superheater, economizer, and an air heater, the new integral-furnace boiler of the Babcock & Wilcox Co. is particularly applicable in industrial plants where operation at high nominal ratings with high final steam temperatures and at high efficiency is desired.

Arrangement of the boiler proper, with inclined tubes entering an upper and a lower drum, and with the furnace paralleling the drums and separated from the rows of tubes by a furnace wall, instead of the conventional arrangement of boiler set over furnace,



NEW 2-DRUM BOILER INCORPORATED IN FLEXIBLE UNIT PARTICULARLY ADAPTABLE FOR INDUSTRIAL SERVICE

makes its installation advantageous where headroom is limited.

The furnace is water-cooled with side walls of Bailey Stud-Tube construction and the floor of straight tubes covered with standard Bailey blocks. The tubes of the floor and outer sidewall connect to a common header in such a manner that positive circulation is assured through the floor and the wall.

Ash Removal

The rear wall, of refractory construction, is protected by a row of bare water-cooled tubes. Protection of the boiler tubes and superheater is obtained by a slag screen, formed by the first two rows of boiler tubes. These tubes are offset or staggered and are spaced on wider centers than those directly behind them. The unit is suitable for either wet or dry ash removal.

In the boiler shown, arranged for dry ash removal, one ash pit, approximately 2 ft. deep, extends across the back of the furnace, in the form of a trough, and provides a receptacle for ashes, which may be easily raked into it from doors at the floor-level in the rear wall, or swept to the rear from the front wall by a steam lance. The ash pit is emptied through doors at the rear. Where conditions warrant their use, hopper-bottom and slag-tap types of furnaces provide alternate methods of ash disposal.

Boiler tubes are arranged in three passes, with a draft loss that is sufficiently low to permit operation with natural draft up to fairly high ratings. The tubes in the first pass are 3¼ in. in diam. and those in the succeeding passes 2 in. Tubes are on alternate wide and narrow centers to facilitate their renewal and can be cleaned with standard turbines.

Suitable for All Fuels

Drums are of fusion-welded or, if desired, riveted construction. The lower drum rests upon cast-iron saddles, which, in turn are supported by footings. It is anchored by the saddle near one end, but is free to move at the other end. The upper drum is supported by beams carried on corner columns and, in the larger sizes, by auxiliary guides and supports secured to the buckstays and rear corner angles. It is equipped with the necessary steam-and-water separator to assure the delivery of dry steam. Steam enters the dry pan at the front of the boiler where the water is comparatively quiet, passes over the length of the dry pan, and is taken away from the rear of the drum to the superheater.

Fuels, such as pulverized coal, oil, or gas can be fired singly or in any combination, and conversion from one or any combination of these fuels to another can be accomplished without any changes to the boiler or furnace.

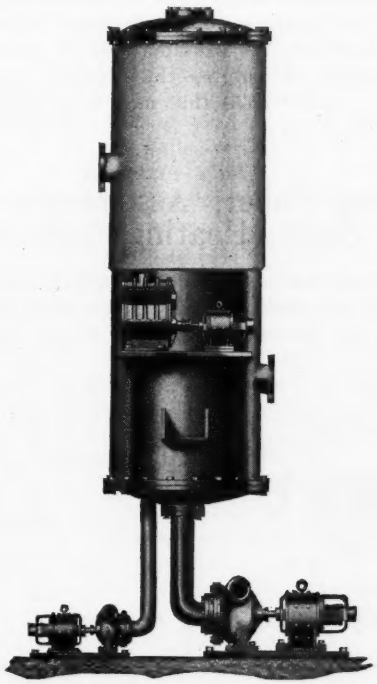
Carbon monoxide is poisonous if actually breathed. It combines with the blood but if the person asphyxiated is removed to the fresh air the carbon monoxide leaves the blood in a few hours. If the asphyxiation has not been too long and too severe and first aid treatment has been prompt and correct, the patient will recover completely according to the National Safety Council.

Concentrations as low as one tenth of one per cent will kill a man in time, while 1 per cent will kill him in a few minutes. A handkerchief tied about the nose and mouth is no protection and does not stop carbon monoxide. This gas does not irritate the throat and has no smell. It often paralyzes the legs first so that the victim, even though conscious, falls down and cannot walk or crawl. The only protection is a mask equipped with an air hose or oxygen breathing equipment.

A person overcome with the gas should be removed to a room free from gas and comfortably warm. If breathing is weak or has stopped completely, artificial respiration should be started at once while someone telephones the utility company for an inhalator to be used in conjunction with artificial respiration.

Water Cooled by Steam

IN A NEW DEVELOPMENT of the Elliott Co., Pittsburgh, Pa., water is cooled by means of flash or instantaneous evaporation under vacuum, for drinking purposes, for use in air coolers or air conditioning cabinets, and for other applications which use water cooled to between 40 and 50 deg. F. A tank 2 ft. in diameter and approximately 6 ft. in height contains a low-pressure evaporating compartment, a compressor of the steam jet type and a condenser. Exterior to



UNIT TYPE, STEAM OPERATED COOLER

the tank is a pump for removing and circulating the cooled water and another one to remove the condensing water from the condensing compartment. An auxiliary motor-driven vacuum pump is mounted on the side of the unit to maintain moderately reduced pressure in the condensing compartment. The entire unit occupies a space less than 3 ft. square by 8 ft. high. Water is the refrigerant, cooling being accomplished by direct partial evaporation of the water, the top half of the unit being insulated to avoid absorption of heat by the chilled water.

Low pressure steam, at any available pressure above atmospheric, is admitted through an opening at the top of the tank, while water, to be cooled, enters the upper opening at the side of the tank, into the low-pressure compartment, where the pressure is maintained at 0.3 in. of mercury. This entering water adjusts its temperature to 45 deg., the boiling point at that pressure, by partial evaporation under vacuum. Vacuum is created by a steam jet ejector nozzle through which steam issues at velocities of 3500 to 4500 ft. a sec., drawing vapors from the water entering the vacuum tank and ejecting the mixture into a condenser, from which the motor-driven pump removes the condensate, thus maintaining a moderately reduced pressure and reducing the duty imposed upon the steam jet compressor. Cooled water is pump circulated to where it is to be used, then re-circulated for re-cooling, make-up being added to compensate for any loss of water. Condensing water from city supply or a cooling tower enters the condensing compartment through the lower opening on the side of the tank and is removed by a pump, which re-circulates it to the cooling tower, or discharges it to the sewer.

Using waste steam at 3 lb. pressure, the equipment will produce 15 t. of refrigeration a day at a cost stated to compare favorably with any other method. Advantages are direct evaporation without a chemical, simplicity of design and operation and low upkeep cost.

Elliott coolers, as illustrated, are built in three sizes up to 15 t.; large commercial units for any capacity are available in less compact arrangement which requires more floor space.

Carrier-Current Controls Off-Peak Water Heaters and Street Lights

ABOUT JULY 1 this year, General Electric carrier-current equipment will go into service for the city of Idaho Falls, Idaho, to enable the operator in the municipal power station to turn on and off domestic electric water heaters connected to the city system. This will be the first installation of carrier control for all off-peak water heaters on a system and is designed to make possible the achievement of a higher load-factor than could probably be attained through any other type of control. At the same time, carrier-current equipment is being installed for the control of the Idaho Falls street lights.

The carrier equipment consists of a three-unit motor-alternator in which a 5-hp. induction motor drives one 3-kw., 720-cycle alternator and one 3-kw., 480-cycle alternator. The 720-cycle machine supplies the carrier for water heater control and the 480-cycle machine supplies the carrier for controlling the street lights.

Series coupling transformers, similar to standard current transformers, are placed in each phase of the four feeders leaving the station. Through a plug and jack arrangement, the operator can connect the transformers on any of the feeders to the carrier transmitter, thus giving him control of the water heaters on that feeder independently of all others. Close control of not only the station load-factor but also that of each individual feeder is thereby obtained.

Standard General Electric carrier controllers, mounted in indoor cases, are used at the water-heater locations, their load contactors arranged so close on a carrier impulse of approximately 10 sec. duration and open on an impulse of about 30 sec. duration. These impulses are automatically timed by relays associated with the transmitter control panel and actuated by pressing "on" or "off" push-buttons at the power station.

Similar carrier-current controllers, located in the base of ornamental street-lighting standards and operated by timed impulses from the 480-cycle transmitter, provide remote control of the street lights.

Readers' Conference

Analysis of Coal

SPECIFICATIONS are often used where considerable quantities are purchased so that some degree of consistency can be depended upon when the material is used. Coal is usually sold on a combination price and quality basis and in order to check the quality it is customary to take samples from time to time and have these sent to a laboratory for analysis. This analysis is not difficult and many industrial companies have their own laboratories where the analysis is made, others send the samples out to commercial laboratories.

The usual analysis, termed proximate, is a determination of the moisture, ash, volatile, and fixed carbon as percentages with the heating value and sulphur content sometimes added. The ultimate analysis is a complete determination of the constituent elements of which the coal is composed such as carbon, hydrogen, nitrogen, and oxygen. The ultimate analysis gives data from which the heat value of the coal can be calculated while the proximate analysis, which is not a contraction of the word approximate, gives the data by which it is possible to judge the kind and general character of the fuel and to a certain extent its action in the furnace.

When a sample, which should run from about 3 to 5 lb. is received in a laboratory it is mixed, crushed, ground and divided into a number of smaller portions. The moisture is determined on one sample by heating it to about 220 deg. F. for about an hour, and then weighing the balance. The sample is then put in a dish and heated over an open flame and in a hot furnace, about an hour all together. What remains is considered as ash. Volatile is determined by heating a sample for about 7 min. at a temperature of about 1700 deg. F. Fixed carbon is then determined by subtracting the sum of the percentage of moisture, ash and volatile matter from 100.

The ultimate analysis is elaborate but a comparatively simple method, which is convenient and accurate, is often used for boiler work. This consists of burning the coal sample in a calorimetric bomb with sodium peroxide. Sodium carbonate is formed and this is decomposed by acid, the carbon dioxide being collected and measured so as to calculate the carbon in the coal. Sulphur in the solution is then determined, and the hydrogen, nitrogen and oxygen values calculated from the carbon, sulphur and thermal values. All these steps have been standardized and the procedure laid out in detail so that the results from different laboratories check reasonably well. Heating values are determined by burning a sample of the coal in an atmosphere of oxygen in a so-called bomb. During combustion the bomb is submerged in water and the heating value found by calculation from the temperature rise of the water.

Sometimes the ash and clinker is investigated, either to find out the combustible remaining in it, or, to try and correct clinker troubles in the furnace. The combustible is determined by the loss of weight after carefully burning off the carbon. The melting point of the ash is then found and in a complete analysis of the ash the iron oxide, lime, silica, alumina, soda, potash and magnesia are found and reported.

In addition to being of value to the engineer in checking up to see if the coal quality is being maintained, an accurate knowledge of the heating value is necessary for figuring boiler efficiency tests and the analysis, especially the proximate, is of great interest to the engineer in judging the probable quality and suitability of other coals that may be available.

Brooklyn, N. Y. — P. F. ROGERS.

Repairing Boiler; Assembling Smoke Stack; Heating Rivets

IN REPAIRING a horizontal shell boiler sometime ago I found it necessary to remove a number of broken studs. It was necessary to replace these studs so that

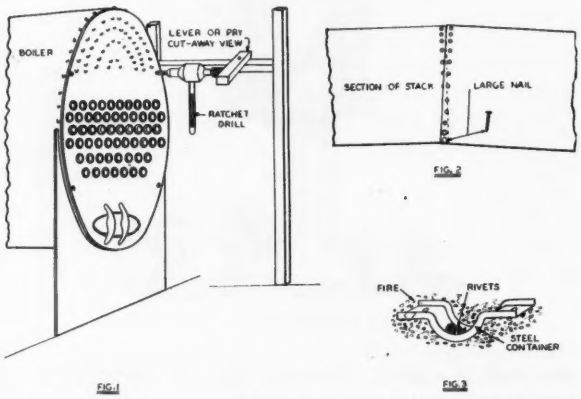


FIG. 1. MEANS FOR DRILLING BROKEN STUD BOLTS
FIG. 2. NAILS AID IN ASSEMBLING SECTIONS OF SMOKE-STACK
FIG. 3. METAL CONTAINER PREVENTS LOSS OF RIVETS IN FORGE FIRE

the rim (or front) which served as a support for the smoke stack, could be bolted in place at the front end of the boiler. Since I did not have access to all the modern tools now in use, I was compelled to resort to any methods my ingenuity might suggest. After obtaining a ratchet drill, I built up a sort of framework or scaffold about the end of the boiler (Fig. 1). Then a wooden lever, or pry, was nailed with one large nail to a beam running parallel with the shell, the space between the end of the boiler and the lever being such that it accommodated a ratchet drill as shown in Fig. 1.

To give the drill bit a start in the exact center of a stud, a center punch was used, and after placing the drill in position and pressing the lever against it, drilling was begun. Although this proved to be a slow

method, the job was satisfactorily completed. After drilling through the broken studs, the remaining thin shell was removed by means of a cold chisel and hammer.

Assembling small portable smoke stacks is sometimes a difficult and aggravating job. It is not always easy to slip the end of one section into the end of another. Oftentimes when one side of the section is slipped into place, the other side is pulled out and the whole thing has to be done over. Another difficulty is that of making all the holes line exactly.

I have learned that the manipulation of sections can be considerably facilitated by using a number of large nails in the manner indicated in Fig. 2. Insert a nail as soon as two holes are in line and continue in this manner until the whole section is in place and all holes are properly lined. The nails are then removed one or more at a time to make room for rivets. A long, tapering punch is quite helpful in doing work of this kind, as it can be used to great advantage in lining holes. If the nails impede the action of the "head-holder" inside the stack, first put in a rivet at each of the four "corners" and then remove the remaining nails all at once.

Rivets are easily lost in the fire when heating them in a small portable forge. They seem to work their way constantly downward and soon become hidden under the fuel as the latter burns out and caves in. To overcome this trouble on a recent job, I made use of a trough-like piece of steel picked up from a scrap pile. In this particular case I used the hub piece of a steel split pulley, placing the rivets in the depression and putting the whole thing in the fire as shown in Fig. 3. Almost any thin trough-shaped object made of steel can be used for this purpose. The metal soon becomes red hot and heats the rivets, but none of the latter can sink downward and become lost in the fire as often happens when a receptacle is not used. This idea is more applicable when heating small rivets, as large ones are not so easily lost in the fire.

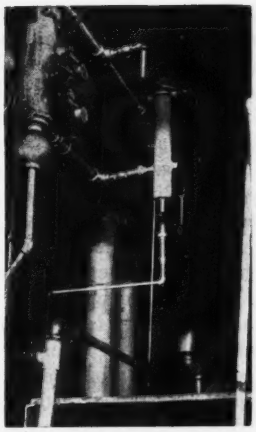
McCool, Miss. BUNYON KENNEDY.

Remote Reading Water Level Indicator

WITH THE PRESENT DAY tendency toward larger and higher boiler units it becomes more and more difficult for the boiler room attendant to know positively the height of the water in the gage glass due to the water column being so far above his line of vision. Many and varied attempts have been made to overcome this difficulty with varying degrees of success.

An electrically operated outfit has been devised by the writer which has proved, by an actual operating test for five months a perfectly satisfactory solution to this difficulty.

The device consists of a water column, auxiliary to the main water column, in which there is a float and mounted upon this float is a bundle of fine iron wires, forming a rod about ½ in. in dameter, which is used as a magnetic core. Mounted on the top of this column, each above the other, is a series of six electromagnets with hollow centers. These coils are so connected as to form a kind of transformer. Three of them, alternating, are connected in series across the



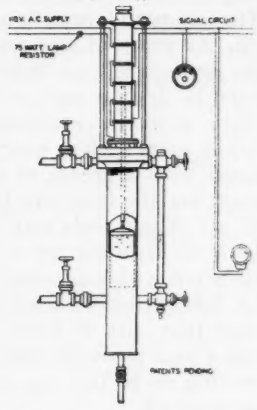


FIG. 1. WATER LEVEL INDICATOR INSTALLED
FIG. 2. DIAGRAM OF BOYD WATER LEVEL INDICATOR

line of the 110-v. a.c. lighting circuit, forming the primary and the other three are connected in series and forms the secondary or signaling circuit.

Extending through these coils is a non-magnetic tube having its lower end open into the steam space of the water column and into which projects the iron core which is mounted on the float. Both ends of the tube are made steam tight in a similar manner to that of the glass in an ordinary water column. The float and core are free to rise and fall with the variations of the water within the column.

When the water is at its lowest point in the column the core is just entering the lowest coil and the voltage in the secondary or signal circuit reads zero on the indicator, which is nothing more or less than a voltmeter. When the water is at its highest point, the core extending completely through all of the coils the instrument reads 25 v. At any point between these two extremes where the float and core happen to rest the voltage has a proportionate value. The float rides freely without friction upon the water and follows the variations in water level with precision. It is expected that the outfit will continue to operate for many years without attention.

Knoxville, Tenn. F. M. BOYD.

Care of Pneumatic Tools

AIR-OPERATED tools for boiler cleaning and similar operations are much used. If properly used these give entire satisfaction. Essentials are, clean air, a sufficient air pressure and ample lubrication. The air should, if possible, be drawn from a source where it is cool, clean and dry. A strainer should be put over the air intake pipe; this may be conveniently done by placing some wire netting around the inlet and covering this with two layers of muslin. A filter should also be placed in the air line before each pneumatic tool. These filters should be cleaned and inspected at regular intervals. If found to be worn so that they will pass dirt with the air, they should be repaired or replaced. They should be kept clean, as clogged filters are ineffective and cause considerable air pressure loss. This may cause the tools to fall off in speed and therefore operate less efficiently. The pipework and hoses used must be of ample size and any curves

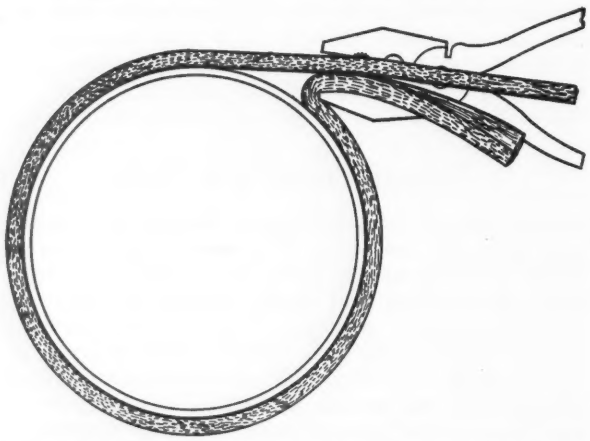
large, so that pressure losses are kept to a minimum. The internal lubrication should be by light machine oil. As many of the parts are in direct contact with the compressed air there is a tendency for the lubricant to dry up and be carried through the exhaust. With tools in constant use lubricate every hour. Other parts such as gear and crank cases can be lubricated with a grease or heavy oil. With tools in constant use the lubricant level should be made up every 12 hr. These tools may be cleaned by immersing in a bath of kerosene for a few hours and then blowing them out with compressed air. This should be followed by lubricating with a light machine oil. It is important that dirt is kept out of the system, therefore hoses and pipework should be blown out before connecting up so that any pipe scale or accumulated dirt is removed.

Herts, England. W. E. WARNER.

Engineer's Useful Pipe Wrench

THE ACCOMPANYING SKETCH shows how easy it is to make a good "pipe wrench" out of a leather strap and a pair of pliers. Wrap the strap around the article to be turned, as shown, and grasp both ends close to the article with the pliers. If it is desired to tighten the thread turn clockwise as in the sketch. If the thread is to be loosened, simply pull the other way just as with any regular wrench. This idea is of especial value where the article is nickeled or polished and must not be scratched as the leather forms a cushion between the pliers and the metal. If it is thought that a single thickness of leather will not be strong enough it is a simple matter to use two thicknesses or more. Thus the method really has no size limit, provided one has a strap that is long enough. What is more, the strap need not be leather. Any strong, flexible material will do—even rope.

Newark, N. J. W. F. SCHAPHORST.



STRONG SNUBBING ACTION MAY BE DEVELOPED IN THIS MANNER

Auxiliary Power Problem

A MANUFACTURER uses in one month about 36,000 kw-hr. of purchased current and has a demand of 100 kw. There is, on the property, an old water power site with a wheel which will develop about 60 b.hp. The wheel itself is in good condition, but it will take some money to put it in shape. Water is plentiful for about 2 mo. in the year. About 2 hr. per day running would be all that could be obtained during the rest of the year. Would it pay to develop the water power as an auxiliary and about how much could he expect in return?

There are several things to be taken into consideration. His peak load comes on for about 2 hr. a day or a little less. The extra generated power would therefore be used during these hours and could cut down his demand charges by the number of kilowatts generated. It is supposed that he will be able to generate at least 30 kw. for the 2 hr. peak period. This would cut his demand charge basis from 100 to 70 kw. With a demand charge of $1.00 per kilowatt, there would be a direct saving on this charge of $30.00 per month. In addition to this saving there would also be generated 60 kw-hr., 30 days a month or 1800 kw-hr. per month, or 21,600 kw-hr. per yr. Charging this at the lowest rate he obtains or $0.015 per kw-hr., the saving during the month would be $27.00 a month, or $324.00 per yr. With a saving on the demand charge of $30.00 a month, or $360.00 a year, plus the saving in kilowatt hours generated, the yearly saving would be $684. This would represent the interest on a sum of $11,400. In other words if the total cost of investment does not run higher than this figure it would probably pay to install a power unit.

It is estimated that a 50-kv.a. generator for 440-v., 60-cycle, 3-phase operation would cost in the neighborhood of $1300, including part of the drive and using a high speed generator. Another consideration which has not been mentioned before is the possibility of using the generator as a synchronous condenser floating on the line for power factor correction. Due to the characteristics of the load, most of the correction would be done while the machine was operating as a generator. If it is desired to operate the generator as a motor a clutch would have to be provided between the generator and the water wheel and the machine would float on the line with field adjusted to take care of the wattless load. The clutch would have to be an expensive one as it would operate continuously and would have to be built accordingly. The estimated costs would run about as follows:

Generator, new with drive	$1,300.00
Balance of drive, clutch, etc	400.00
Switchboard and instruments	350.00
Wiring, labor, etc	500.00
Total	$2,550.00

The total installation cost would, allowing for contingencies, not exceed $3000. The interest on this amount at 6 per cent would come to $180.00 a year. The saving per year would be cut to $504.00. However, this is still worth saving, and is in addition to the operating advantages which the installation would give. Maintenance should not be high and no taxes have been figured in as these would be paid whether he used the power or not. While it would be impossible to figure accurately the amount which would be saved, it is indicated by the preliminary figures that a substantial saving would result and consequently the outfit should be in-

stalled. During a good year when the rains are heavy a larger proportion of the total load could be carried by the waterpower plant and would be pure again. Then, too, should the total load be cut way down, say when only repair work was being done, the little power needed could be entirely supplied by the water wheel.

The advantages of the possession of an auxiliary unit are the cutting down of the demand factor, the actual generation of power which will not have to be bought, the correction of power factor if necessary (many contracts now have an 80 per cent power factor clause in them), the water power can be used for emergency purposes should the purchased power ever fail for some reason or other, and besides this the actual gain in cash.

There are perhaps over the country many such situations where it has been felt that the amount of power that could be developed was not worth bothering with. As has been shown even with a 50-kw. installation, there are possibilities. Perhaps the owner has shied off because of anticipated operating difficulties.

Of course, not all situations are as simple as the one illustrated and in some cases there would be excessive costs connected with installing a generator and water wheel, but if the costs are not excessive, an auxiliary unit is a paying proposition.

Waterloo, Wis. K. B. HUMPHREY.

Combustion Air Requirements for Coal, Oil and Gas

TO ARRIVE at the approximate amount of air required for the combustion of different fuels, the following method may be helpful to many designers of boiler room equipment, especially as in the majority of cases, there is no guarantee that exactly the same grade of fuel will be used at all times.

Time can be wasted in working out the theoretical amount of air which would be required to burn coal having certain assumed characteristics and it is then a guess as to how near this coal will come to the average fuel which will be used over a course of years. The writer feels that the application of the following methods, based upon reasonable maximum assumptions as to the grade of fuel, will give results which are satisfactory for all practical purposes of design, in connection with air intake openings, forced draft systems, and other details of boiler and furnace installations.

Investigation of the characteristics of different fuels generally found in boiler rooms will show that the theoretical number of cubic feet of free air at average room temperature, required to burn any of them, is very nearly one per cent of the B.t.u. value of the fuel.

Let us consider the air necessary to burn "Bunker C" oil. It is quite common practice to assume that 220 cu. ft. of air will be adequate for one pound of oil.

If we apply the above rule, we shall find that oil containing 18,500 B.t.u. per pound would theoretically require 185 cu. ft. of air per pound of oil, and if to this we add 20 per cent excess, we obtain a figure of 222 cu. ft., which checks almost exactly with the generally used figure of 220 cu. ft.

In the case of 14,000 B.t.u. coal, we should require 140 cu. ft. of air per pound, plus whatever excess judgment would indicate. For instance; 40 per cent, in which case, the air required would be 196, or say 200 cu. ft.

This rule can be applied to gas, to figure the number of cubic feet of air per cubic foot of gas, and as this method gives results which are more accurate than any estimate which it is generally possible to make of the maximum quantity of fuel to be burned, it should serve for all purposes of practical design; as any attempt to arrive at exact results based upon purely hypothetical operating conditions, is generally a waste of time.

In designing smoke flues and induced draft equipment, it is quite common practice to estimate 20 lb. of flue gas per pound of fuel, which, at 580 deg. F., would equal approximately 500 cu. ft., or 25 cu. ft. per lb.

Of course purely theoretical considerations would indicate that in the majority of cases this is somewhat high, but it is a perfectly safe rule to follow, and where the exact operating conditions are uncertain, an estimate of 18 lb., or 240 cu. ft. per lb. of coal should provide a liberal estimate of the air to be handled by forced draft equipment.

Bloomfield, N. J. JAMES O. G. GIBBONS.

Tell-Tale Lights for Power Waste Prevention

IN PLANTS which are sometimes considerably taxed to deliver the peak load called for, it becomes a thing of especial value to avoid all undue waste of power, though a saving in this direction is of course worth while in any event. In the case of a large blower fan being run in a woodworking factory, to carry the shavings away from a big double-surfacing planer, such a case of waste was found and eliminated. The planer operated only a small portion of the time, and the other machines in the shop were connected to a different exhaust system. Orders were issued by the management to shut off the fan for the planer at the time the planer was stopped, but it developed that though the operator meant to do this, he was often in considerable of a hurry and overlooked doing so. The fan ran more quietly than the surrounding machines, so that its continuance in operation was not suspected until the other machines went down at noon or evening.

In order to overcome this oft-recurring power waste, a red light was connected into the fan circuit so that while the fan was running the light was on, and when it stopped the light went out. This light was positioned where the operator of the planer was sure to see it more or less continually, and served as a reminder to turn off the fan. Similar cases can, of course, be similarly handled anywhere.

Peoria, Ill. JOHN E. HYLER.

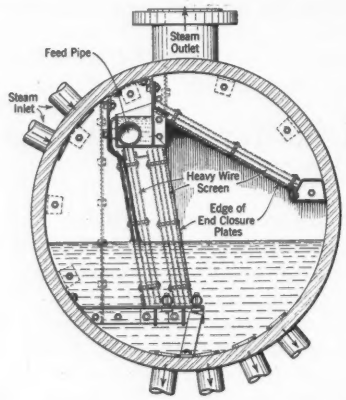
WHEN THE PRIMARIES of three transformers are connected in star to a 3-phase, 4-wire circuit, the line currents will have the same wave form as that for one transformer on a single-phase circuit. If the transformers are identical and the voltages balanced, the neutral will carry only third harmonic current. The voltage across each transformer will be less than line voltage in the ratio of 1 to $\sqrt{3}$.

New Equipment

C-E Steam Washer

WITH THE OBJECT of reducing the solid contents in the steam leaving the boiler and the consequent protection of the superheater and turbine blading, Combustion Engineering Co., Inc., New York City, has developed a steam washer for placing within the steam drum.

Water from the feed box spreads over the initial screen and forms a curtain through which the steam must pass on its way to the outlet at the top of the drum. This washes the steam with the clean



feedwater and removes much of the solid content. The subsequent screens through which the steam must pass are for the purpose of removing entrained water. The moisture content of the steam leaving the boiler drum is not increased as a result of the washing under these conditions and it is probable that the reduction in film tension actually decreases the tendency to carry over suspended particles of water.

Heavy wire screen sections are made up in panels of such size that they can be passed through the drum-head manholes. All except the overhead screens ahead of the steam outlet are assembled and secured in place without the use of bolts or the use of tools.

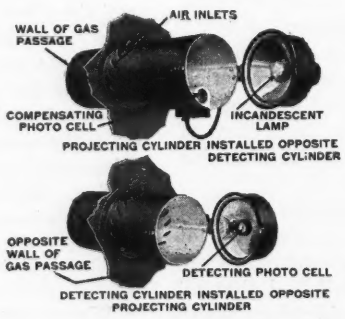
Where all steam from the boiler tubes and water walls enters on one side of the drum a single washer arrangement, as shown, is employed. If the steam enters on both sides of the drum a duplex arrangement of washers is necessary. This consists merely of a second set of screens on the opposite side of the drum.

New Smoke Recorder Is Is Compensated

BAILEY METER CO., Cleveland, O., has announced a new photo cell smoke density recorder compensated for variations in light source intensity and operated by the galvatron electronic relay circuit. This equipment consists of a receiving element in the form of a recorder which is usually mounted on the individual boiler panel board and a transmitting element consisting of a projecting cylinder and a detecting cylinder which are mounted on opposite sides of the breeching or flue gas passage.

A continuous record of relative smoke density is made by the recorder on a 12-in. uniformly graduated recording chart. This record clearly indicates stack conditions at all times, night and day, showing definitely each period of tube blowing. A hinged panel within the dustproof pressed steel recorder casing provides the chart plate on one side and on the other side an easily accessible mounting for the sensitive galvanometer and electronic relays of the galvatron.

Two photo cells are employed in the transmitting element, one in the projecting cylinder and the other in the detecting cylinder. Full luminous flux from the incandescent lamp light source is received by the compensating cell at all times regardless of the smoke density condition within the gas passage. The photo cell, however, located in the

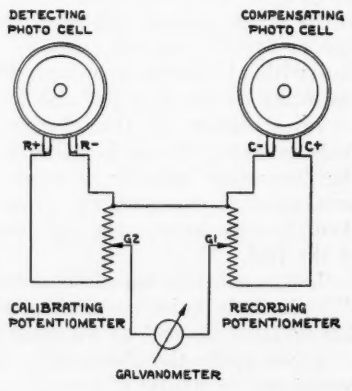


detecting cylinder on the opposite side of the gas passage receives light of varying intensities, depending upon the density of the smoke in the passage. Both cells consist of a thin metallic disk covered with light sensitive material which develops a current proportional to the intensity of illumination.

The method by which variations of light source intensity are compensated for is clearly shown in the accompanying electrical circuit diagram. To accomplish this, the calibrating potentiometer is connected in series with the detecting photo cell and the recording potentiometer is connected in series with the compensating photo cell. Negative terminals of both cells are connected so that they will be at the same potential.

When the light to the detecting photo cell is reduced by passage of smoke between the cell and light source, the voltage output of the cell is reduced and the potential of G_2 drops, causing a current flow in the galvanometer circuit. This unbalanced condition causes the galvatron to move contact G_1 toward the negative terminal until a decreased voltage point is reached comparable to that of G_2 when no current flows in the galvanometer circuit. Since this movement of contact G_1, necessary to balance the potential of G_1 and G_2, is proportional to the smoke density in the gas passage, moving contact G_1 is geared to the pen which records relative smoke density on the chart.

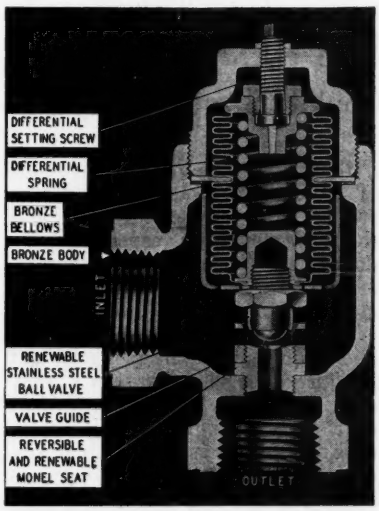
Since intensity variation of the light source changes the output of each cell in the same proportion, the position of the recording potentiometer contact G_1 is determined



by the ratio of light intensities received by the two cells, and therefore accurately records the true relative smoke density at all times, regardless of such factors as voltage variations and loss of incandescent lamp efficiency.

Tag Thermostatic Steam Traps

THE C. J. TAGLIABUE MFG. CO. of Brooklyn, N. Y., has recently brought out a thermostatic steam trap for industrial use which has new and improved features. These traps are now offered in ½, ¾ and 1 in. sizes. The TAG differential set-



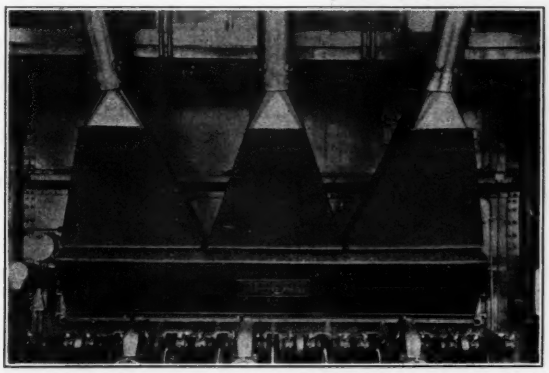
ting feature has been retained and continues to assure actual saving of steam. An adjusting screw located at the top of the trap may be set to discharge condensate at a temperature corresponding to as much as 20 lb. less than the operating steam pressure, whether it is 50, 75 or 125 lb., without any further adjustment.

Other outstanding advantages are the renewable and reversible double life monel seat, and a renewable stainless steel ball valve. As a further protection the renewable valve guide holds the ball valve central to the seat and thus insures tight closing.

The Fairfield Non-Segregating Coal Distributor

NON-SEGREGATING COAL distributors, developed by the Fairfield Engineering Co., Marion, Ohio, are designed to prevent the segregation of coal fed to stoker hoppers which is accomplished by the use of an ingenious arrangement of fixed internal deflecting vanes. Two series of these vanes are used, diverging and running substantially parallel to the spreading sides of the chute. These, as soon as the chute is filled, form supply channels for multiple small feed streams covering the entire inner part of the chute, which flows under confinement in straight lines to the stoker hopper, without opportunity for spreading.

There is by this method no opportunity for segregation in the spreaders. Coal is delivered across the entire surface of the grates just as it comes from the bunkers, assuring a uniform fire bed and superior combustion.

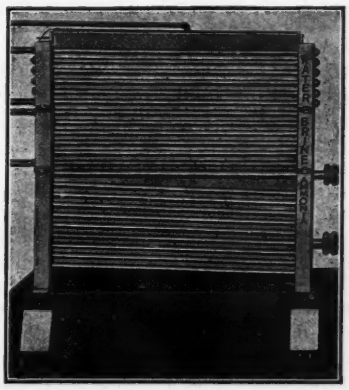


Carbondale Three-Stage Wort Cooler

CARBONDALE MACHINE CO., Carbondale, Pa., has recently developed a new wort cooler, a typical design of which is shown in the accompanying illustration. A saving of 25 per cent claimed for this cooler is effected by utilizing three cooling mediums, as follows:

1. Water. In the first stage, at the top of the cooler, the ordinary available water supply is employed to absorb a large percentage of the heat from the wort.

2. Brine. A stored supply of refrigerated brine is employed to reduce further the temperature of the wort, bringing it down almost



to the temperature of the brine itself. Sometimes refrigerated water is used in this stage.

3. Ammonia. In the last stage direct expansion of ammonia is depended upon to produce the desired final wort temperature. Since the "boiling temperature" of ammonia can, with the refrigerating machine, be adjusted to the needs of the system, it is not a difficult matter to produce any desired wort temperature.

In the design of these coolers for various plants, the areas of the brine and ammonia stages vary with the work done by the available water supply of the water stage. The colder the water supply, the smaller the brine and ammonia stages.

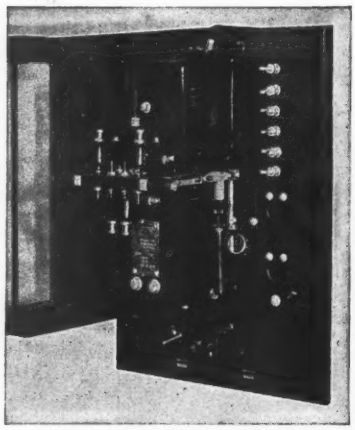
In all of the stages the counter-flow principle is followed—the cold mediums flowing upward in the piping against the down-flowing wort.

New Westinghouse Generator Voltage Regulators

FOR USE EITHER as an exciter or as a generator rheostatic regulator, Westinghouse Electric & Manufacturing Company has developed a regulator of the rheostatic type utilizing conventional motor operated rheostats and contactor panels. The control element from which the regulator derives its name, was developed especially for marine use, in which conditions of shock and tilt must be met.

The control element employs the dynamic principle such as is utilized in the familiar dynamic speaker for radio use. It accommodates two sets of contacts, one of which is used to operate the motor operated rheostat under minor voltage fluctuation, and the other of which functions under major voltage fluctuations to actuate the contactors which short circuit the resistance of the rheosat. The control element can be employed for either alternating current or direct current equipment without modify-

ing the element itself. The only changes necessary are those in the supply to the control element from the voltage source which is to be regulated. When being used on alternating current systems of the



standard 3 phase type, the regulator functions to maintain an average voltage on the three phases.

The control element is enclosed in a glass case which is supported by an insulating base 10 in. wide by 14 in. high. The total extension 8½ in. from the front of the panel on which the regulator is mounted.

Roots-Connersville New Compressor Unit

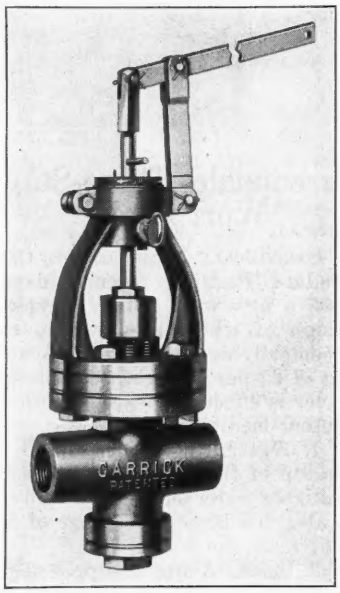
CORPORATION of Connersville, Ind., has announced an addition to its line of centrifugal compressors and exhausters, which is a single-stage unit known as Type OIB. In this design, the machines have their own shafts and bearings and are suitable for direct connection to standard electric motors or steam turbines without special shaft extensions. They are also adaptable to V-belt or flat belt drive.

Impellers are furnished in aluminum or carbon steel in standard construction but special alloys can be supplied where conditions require. For the smaller size, open type impellers and anti-friction bearings are used, and for larger sizes, the closed type impellers and sleeve bearings.

Carrick Flo-Trol Valve

CARRICK adjustable Flo-trol valve, a recently developed product of Carrick Engineering Co., Michigan City, Ind., is of the moving plug type. The valve body and all external parts, except the lever, are of cast hard bronze for ordinary steam pressures and temperatures. For high steam pressures and temperatures the body and head flange coming in contact with the steam are of cast steel. Other external parts are of gray cast iron. The operating lever is always of monel and the stem of stainless steel. Steam passing through the valve does not come in contact with the valve seats, eliminating the effects of wire drawing. Although the valve is designed primarily for the control of steam it is entirely suitable for the control of other fluids, such as oil, gas or air.

This valve is generally controlled by some automatic device, such as the Carrick master control. In such a case the valve is part of a combustion control system. The lever of the valve is moved automatically to secure a variation of steam flow for speed control of the



engine or turbine driving the stoker or fan. The manually adjustable feature of the valve makes it possible to secure the required range of speed to be effected by the movement of the valve lever. All adjustments can be made easily, while the valve is in service.

A. S. M. E. Nominates Officers

AT THE SEMI-ANNUAL meeting of the American Society of Mechanical Engineers held in Denver during the week of June 25th, the nominating committee presented the following names to be balloted on by the entire membership, election closing on September 25:

President, R. E. Flanders, president, Jones & Lamson Machine Co., Springfield, Vt.

Vice-Presidents, E. W. O'Brien, Editor Southern Power Journal, 1020 Grant Bldg., Atlanta, Ga.; Jas. H. Herron, president, Jas. H. Herron Co., 1360 W. 3rd St., Cleveland, Ohio; H. R. Westcott, president, Westcott & Mapes, Inc., 139 Orange St., New Haven, Conn.

Managers, B. M. Brigman, Dean Speed Scientific School, University of Louisville, Louisville, Ky.; Alfred Iddles, vice-president, United Engineers & Constructors, Inc., 1401 Arch St., Philadelphia, Pa.; J. W. Haney, professor, University of Nebraska, Lincoln, Nebr.

Coal Utilization Meeting

AT THE Short Course in Coal Utilization, given at the University of Illinois, July 12-14, the topics covered were types of coal and their preparation, especially for domestic use; fundamental requirements for good combustion equipment and types available; fitting of fuel to combustion equipment; and requirements in firing to get good results. That it was a busy meeting is indicated from the fact that three sessions were held on each of two days and a final session on Saturday. Some 25 papers and addresses were presented and discussed. The program was well devised to cover, briefly but thoroughly, the questions of coal selection and utilization and the various phases were presented in an interesting and practical way.

Points on which special stress was placed were the necessity for consumer satisfaction and that coal producer and distributor should be vitally interested that equipment is adequate and in good condition, that fuel supplied is suitable for the plant where it is to be used and is uniform in character and quality, and that it is so burned as to give convenience and economy.

Attendance was from 14 states, ranging from Utah to Pennsylvania and So. Carolina.

At the Thursday evening session President Willard of the University of Illinois offered to the coal industry the services of the staff and experiment station of the University for supervising and carrying out investigations on characteristics, preparation and use of coal to secure better utilization and at the Saturday session, resolutions were adopted favoring the acceptance of this offer and the setting up of a coöperative board from the industry to act with the University in such investigations.

Discussions showed a lively appreciation among the coal men present of the need of activity to meet competition of other fuels and bring

about a better understanding of the possibilities and advantages of solid fuel for heating, industrial and power use.

Professor A. C. Callen, who was in charge of the course, and Professor D. R. Mitchell, to whom Professor Callen gave credit for the details of arrangement, are to be congratulated on doing a good job and on the success of their efforts. The course was well worth the attendance of coal operators, coal distributors and salesmen and coal users.

Electrical Engineers Elect Officers

J. ALLEN JOHNSON, Chief Electrical Engineer, Buffalo, Niagara & Eastern Power Corp., Buffalo, N. Y., was elected president of the American Institute of Electrical Engineers for the year beginning August 1, 1934, as announced at the annual meeting of the Institute held at Hot Springs, Va., during the annual summer convention of the Institute. The other officers elected were: Vice-Presidents W. H. Timbie, Cambridge, Mass.; R. H. Tapscott, New York, N. Y.; G. G. Post, Milwaukee, Wis.; F. J. Meyer, Oklahoma City, Okla.; F. O. McMillan, Corvallis, Ore.—Directors F. Malcolm Farmer, New York, N. Y.; N. E. Funk, Philadelphia, Pa.; H. B. Gear, Chicago, Ill.—National Treasurer W. I. Slichter (reelected), New York, N. Y.

These officers, together with the following hold-over officers, will constitute the Board of Directors for the next administrative year, beginning August 1, 1934: J. B. Whitehead (retiring president), Baltimore, Md.; H. P. Charlesworth, New York, N. Y.; R. B. Bonney, Denver, Colo.; F. M. Craft, Atlanta, Ga.; A. H. Hull, Toronto, Ont.; R. W. Sorensen, Pasadena, Calif.; A. M. Wilson, Cincinnati, Ohio; L. W. Chubb, East Pittsburgh, Pa.; B. D. Hull, Dallas, Tex.; P. B. Juhnke, Chicago, Ill.; G. A. Kositzky, Cleveland, Ohio; Everett S. Lee, Schenectady, N. Y.; A. H. Lovell, Ann Arbor, Mich.; L. W. W. Morrow, New York, N. Y.; A. C. Stevens, Schenectady, N. Y.; H. R. Woodrow, Brooklyn, N. Y.

The annual report of the Board of Directors, presented at the meeting, showed a total membership on April 30, 1934, of 15,230. In addition to two national conventions and one District meeting, 1,487 meetings were held during the year by the local Organizations of the Institute in the principal cities and educational institutions in the United States, Canada, and Mexico.

News From the Field

IMPROVEMENTS to the McPherson, Kans., municipal plant are being rapidly carried forward as P.W.A. Project No. 4677 under the direction of Burns & McDonnell Engineering Co., of Kansas City, Mo. This project consists of forced draft cooling tower, replacing the old atmospheric tower; a 3000-kw. turbo-generator with a 5000 sq. ft., 2-pass water box condenser; necessary circulating water and condensate pumps; low pressure extraction heaters for the new turbine and the present 2000-kw. unit; a deaerating feedwater heater; new evaporator; necessary piping, wiring and switchboard additions.

The turbine room will be modernized and the gabled roof of the old building replaced with a complete deck at a higher elevation. The turbine room area will be increased sufficiently to take care of the new generating unit, and a single motor traveling crane will be added to facilitate installation and maintenance.

Contract for the turbo-generator was recently awarded to the Elliott Co.; for the condenser to the Westinghouse Elec. & Mfg. Co.; and for the forced draft cooling tower to the Marley Co. Specifications for building changes and additions and miscellaneous equipment will be issued soon.

FOUNDED IN 1884 by John Hill Whiting, the Whiting Corp., Harvey, Ill., is celebrating its fiftieth anniversary this year with Mr. Whiting still active as Chairman of the Board. With a background of foundry experience and having secured a number of patents on foundry equipment, Mr. Whiting launched the Detroit Foundry Equipment Co. In 1894 the plant was located at Harvey, Ill., and business conducted under the firm name of Whiting Foundry Equipment Co., later changed to Whiting Corp. Cupolas and foundry equipment were the principal products rounded out with additional lines such as electric traveling cranes, railroad shop equipment, special machinery for power plants, steel mills and coke plants. The first successful gasoline motor trucks for commercial use were the product of the Whiting plant in 1904.

During the course of progress, other companies taken on as subsidiaries include Swenson Evaporator Co., Grindle Fuel Equipment Co., and Joseph Harrington Co. General T. S. Hammond, now President of the corporation, has been closely associated with Mr. Whiting for the past thirty years and Stevens H. Hammond, Assistant to the President, a grandson of Mr. Whiting, represents the third generation actively engaged in the direction of the corporation.

JOHN ARMS, heretofore general manager of United Engineering Trustees, Inc. has been elected secretary and will be chief administrative officer in caring for Engineering Societies Building in New York, the Library and Endowment fund held by the Corporation for the national, civil, mining, mechanical and electrical engineering societies, the total value of properties being some $4,000,000. A. D. Thinn, who has been secretary since 1918, recently giving one fourth of his time to the work, will give all his time to Engineering Foundation, as its Director and Secretary.

ALLIS-CHALMERS MFG. CO. announces the appointment of W. R. Judson as Manager of the Salt Lake City district office, located in the Kearns Building, Salt Lake City, Utah. For the past 3 yr. Mr. Judson has been Managing Director of Allis-Chalmers (France), representing the Allis-Chalmers Mfg. Co. in Europe. Prior to that time, for 13 yr. he was Manager of the Company Office at Santiago, Chile, covering Chile, Peru, and Bolivia. In Salt Lake Mr. Judson succeeds H. E. Weiss, who has been transferred to the Company's office at Kansas City.

IRON FIREMAN MFG. CO., Portland, Ore., announces the appointment of Thomas A. Marsh, formerly president of the Modern Coal Burner Co. of Chicago, as central division engineer with offices in Chicago. Mr. Marsh was graduated from the University of Illinois in 1904 and has spent his entire professional career in the field of fuels and fuel burning equipment, having been associated with the Green Engineering Co. of E. Chicago, Ind., the Combustion Engineering Co. of New York, the Modern Coal Burner Co. of Chicago, and is serving as a member of the executive committee of the Fuels Division of the American Society of Mechanical Engineers, also as a member of the Citizens Advisory Board of Engineers, Chicago Department of Smoke Abatement, and is also president of the Midwest Stoker Assn. of Chicago.

RILEY STOKER CORP. announces that Paul T. Buckler is now associated with the New York City sales organization with headquarters at 103 Park Ave., New York City.

FOSTER ENGINEERING CO., Newark, N. J., announces the appointment of the Crawford Engineering Co. of New York City as agent for that territory and Henry J. Fortier, who has formerly had charge of this territory, has been transferred to the northern New Jersey territory where he will represent the company in its diversified line of automatic valves.

APPOINTMENT of K. B. Bowman as General Superintendent of the steel mill is announced by the Timken Steel & Tube Co. Mr. Bowman was graduated at Case School of Applied Science in 1921 and has been with the Central Steel Co., Central Alloy Steel Co., and Republic Steel Corp., his experience covering metallurgical and operating practice. In 1931 he joined the Timken Steel & Tube Co. as special statistician for F. J. Griffiths, President, later being made manager of the Statistical Department and in 1933 being promoted to Director of Production, in which capacity he has acted until his new appointment.

UNITED STATES CIVIL SERVICE COMMISSION announces competitive examinations for the following positions: Chief Engineering Draftsman, Principal Engineering Draftsman, Senior Engineering Draftsman and Engineering Draftsman. Applications for these positions must be on file with the Commission not later than August 8, 1934. Entrance salaries range from $1800 to $2600 a year and as the services are required for work on ships, the optional branches cover ship piping, ship ventilation, marine engines and boilers, and electrical. Competitors will be rated on drawing, lettering and practical questions, and on their education and experience.

GEORGE A. DAMON, former dean of engineering at the California Institute of Technology, died on June 23 of cerebral congestion, at the age of 63. Mr. Damon was a native of Michigan and during the World's Fair of 1893 in Chicago was on the staff of electrical industries. He served as a draftsman and engineer for Bion J. Arnold from 1895 to 1908 in which position he designed and constructed a number of important hydroelectric plants. Mr. Damon at a later date served as consulting engineer for Los Angeles, Pasadena and Long Beach, Calif.

BROWN INSTRUMENT CO., Philadelphia, Pa., announces the appointment of L. Morton Morley as General Sales Manager. Mr. Morley, former District Manager of the Philadelphia Office, has been associated with The Brown Instrument Co. for the past 15 yr., and in his new position will have complete supervision of all sales, advertising and sales promotional activities.

COMBUSTION ENGINEERING CO., Inc., of New York, and D. J. Murray Manufacturing Co., of Wausau, Wisconsin, announce that they have concluded an agreement for the joint development, manufacture and sale of the Improved Murray-Waern Chemical Recovery System. This system applies to the soda and sulphate pulp and paper manufacturing processes. Its particular advantage is that it provides, in conjunction with a well-established method of chemical reclamation, the necessary equipment for highly efficient heat recovery with correspondingly large production of high pressure steam. Approximately 10,000 lb. of steam is produced per ton of pulp which is about twice the maximum steam production obtained from recovery stems in prevalent use. The entire system represents a thoroughly coördinated overall design with the operating advantages of low labor and maintenance cost and exceptional cleanliness.

MECHANICAL OPERATING economy and efficiency as factors in industrial recovery will be the keynote of the Eleventh National Exposition of Power and Mechanical Engineering to be held in Grand Central Palace, New York City, next December 3 to 8, producing power and products at lowest cost, which requires maximum technical efficiency and the best in equipment, is the present object of industries, the Power Show offering an unique opportunity for study and comparison of apparatus. Much space has been contracted for but good locations are still available. As railroads are adopting high-speed, stream-lined trains, so industries are seeking modern equipment, and are expected to furnish an interested audience for those who have new and improved equipment to present.

THE EDWARD VALVE & MFG. CO., Inc., East Chicago, Ind., announces the appointment of McGregor Engineering Co., 213-14 Midco Building, Tulsa, as its representative in Oklahoma, northern Arkansas and the Texas Panhandle.

For the Engineer's Library

THE ENGINE INDICATOR. By K. J. DeJuhasz. Published by The Instruments Publishing Co., 320 W. 42nd St., New York, N. Y. Size 5½ by 8½ in., cloth, 240 pp. Price $3.75.

Design, theory and special application of the engine indicator brought up to date. The book opens with the early history of the indicator, covers its application for normal and for special purposes, with perhaps a third of the book devoted to modern high speed engine indicators of the optical and electrical type. Indicators for high pressure such as ordinance work, maximum pressures and mean pressures are covered with chapters on testing, calibration and analytical theory. An appendix gives Navy indicator specifications and a bibliography. The book is complete and covers in great detail the technical construction and theory of indicators but makes no attempt to go into the practical application of the indicator or the analysis of indicator cards.

BOILER FEED AND BOILER WATER SOFTENING. By H. K. Blanning and A. D. Rich. Published by Nickerson & Collins Co., Chicago, Ill. Size 8½ by 11 in., flexible fabricoid binding; 150 pages; price $3.00.

This is indeed a boiler operator's manual, prepared by men who from practical experience know what the plant operator needs and the problems he is up against.

Naturally, dealing with a subject of this kind a certain amount of chemistry is necessary but this has been kept to a minimum, bearing in mind that the book is prepared for the average operating engineer and not a trained specialist. Details of preparing various reagents, methods of standardization, sampling and tests are given in detail. The interpretation of these tests, various methods of treatment, meaning of carbonate sulphate relations, caustic embrittlement, corrosion and related subjects are treated in a practical and usable manner. A list giving the common name, chemical name and chemical formula of more than 100 compounds commonly met is included. The charts for the control of various treatments are all full page and large enough to be used in the plant without redrawing.

It is seldom indeed that a book for the operating man is written with a full appreciation of the operating man's troubles and problems by authors who are themselves operating men and know whereof they speak. This book deals with a different subject in a practical usable manner.

MANUAL OF FINANCIAL and Accounting Procedure for Public Bodies, prepared for the Federal Public Works Administration, or P. W. A., by the staff of Public Administration Service, sets forth the method of estimating public works projects, the basis of grants, and complete instructions for the handling of P.W.A. funds.. It also sets forth complete project accounting and cost procedures for construction use so that it is useful not alone to cities obtaining P.W.A. loans and grants, but as many of the recommendations contained are applicable to any kind of municipal construction work, all city engineers and public works officials will find it helpful.

NATIONAL ELECTRICAL CODE HANDBOOK, by Arthur L. Abbott, Second Edition, size 5 by 7¾ in., semi-flexible Fabrikoid, 523 pages illustrated. The McGraw - Hill Book Co., New York, 1934. Price $3.00.

The purpose of Mr. Abbott's book as he states in the preface is to enable the reader to grasp readily the general plan, scope, and intent of the code requirements, to present more or less detailed discussions of the rules wherever anything of practical value can be contributed by such discussion and to make the practical application of the rules clear and easily understandable.

While this book is interesting and well written, it seems rather inconsistent with the purpose of the National Electrical Code that such a book should be necessary. The Code itself, a comparatively small book, sells for a few cents; its purpose is to specify approved material and methods of installing electrical equipment, yet here is a book of some 500 pages and costing $3.00 discussing the code for us. It would seem that if a code was to be worth anything it should at least be understandable in itself. In saying this we imply no criticism of Mr. Abbott's book for it is interesting and the discussion of the code which he presents is instructive and valuable and certainly gives one a better understanding of the code. Where certain materials are specified in the code for example, Mr. Abbott discusses the nature and use of these materials in a detailed way. Also, by means of drawings and illustrations he shows approved methods of doing the work. It is an excellent book for those who have to do electrical work according to code requirements.

CAUSE AND PREVENTION OF CALCIUM SULPHATE SCALE IN STEAM BOILERS, by Frederick G. Straub, has been published as Bulletin No. 261 by the Engineering Experiment Station, University of Illinois, Urbana, Ill. This is a 6 by 9 inch, paper bound booklet of 75 pp. which sells for $0.85. The results of the investigation both in the laboratory and in power plants are discussed in detail and the conclusion reached that the presence of more than 30 parts per million of sodium carbonate in boiler water will prevent the formation of calcium sulphate at pressures up to 2000 lb. per sq. in. and that the carbonate content necessary to prevent sulphate scale is independent of the sulphate concentration within the limits of concentration carried in the average high pressure boiler.

ELEMENTS OF HYDRAULIC POWER GENERATION. By Arthur M. Greene, Jr. Size 6 by 9 in., 58 pages, illustrated, stiff paper cover. Published by John Wiley & Sons, Inc., New York, 1934. Price $1.00.

This excellent little book presents the elements of hydraulic power generation in a simple, easily understandable manner. Its purpose is to give the young engineer and the layman some knowledge of the apparatus used in hydraulic power development, the uses, imitations and the names of these devices. It is intended for upperclassmen as a supplement to a course in theoretical hydraulics by showing the application of this to modern structures. The use of this book in the freshman or sophomore year of the engineering school is intended to form an intimate background of hydraulic machinery and its nomenclature for the theoretical courses in the upper classes.

Aside from its use by college students, the book should be of interest to anyone connected with hydraulic power development or interested in this subject. The basic elements of the art are simply and well explained.

AIR CONDITIONING SIMPLIFIED. Edited by Harold L. Alt. Published by the Domestic Engineering Co., 1900 Prairie Ave., Chicago, Ill. Size 5½ by 8½ in., 210 pages, cloth bound. Price $1.00.

Theory, practice and marketing of modern air conditioning in simple and practical form. The book is divided into three sections; the first section covers the theory of air conditioning; the second, the actual installation, beginning with the floor plans and carrying through the calculations, drawings, costs, etc.; the third part, with methods of selling air conditioning and the selection and teaching of sales prospects about this new and important branch of engineering.

DIESEL HAND BOOK. By Julius Rosbloom. Published by Diesel Engineering Institute, 443 Hoboken Ave., Jersey City, N. J. Size 5 by 8 in., flexible fabricoid binding; 339 pages. Price $5.00.

Intended as a practical book of instruction, about two-thirds of this book is in the form of questions and answers, a large portion of it being devoted to calculations of various sorts which are worked out in detail in the text. Dealing with such a comprehensive subject in such a limited space, much of the text is very general and the theoretical treatment brief. A short chapter deals with indicator practice while another short chapter gives a resume of the experience and practice in Diesel trucks and automobiles.

IN A 4-page bulletin sent out by Imperial Electric Co., Akron, Ohio, the company explains advantages that may be obtained by dealing with the "little fellow" in purchasing electrical equipment and describes its service to buyers of motors and generators.

INGERSOLL-RAND CO., New York City, has issued a bulletin under the title, "A Better Portable Compressor," which sets forth the advantages of the Company's two-stage, air-cooled portable compressor which is built in five sizes ranging from 75 to 370 c.f.m. piston displacement. Both the oil-engine and gasoline-engine driven units are shown in this new building, which also gives details as to the amounts of fuel savings that can be expected compared to operation of single-stage, water-cooled compressors.

THERMIX multi-cyclone dust collectors are described and illustrated in two circulars issued by Prat-Daniel Corp'n of New York City.

FABRICATING of stainless clad steel is explained in detail in a manual issued by Ingersoll Steel & Disc Co., Chicago, Ill. It shows processes for welding, soldering, riveting, lock seams, etc., for IngAclad, which is a soft steel with coating of stainless steel welded on, giving a non-corrodible material for tanks, vats and the like less expensive than solid stainless steel. The manual is clear, interesting and well illustrated.

LINK-BELT CO., Chicago, Ill., has recently published a 16-page illustrated catalog No. 1595 on locomotive cranes. The catalog gives tables of clearance dimensions and rated lifting capacities for machines for operation by either gasoline, Diesel, electric or steam driven power units.

LINK-BELT CO., Chicago, Ill., devotes a 16-page catalog No. 1462 to its line of vibrating screens used with such material as sand, gravel, stone, coal, coke, clay, fertilizer and cement. Several types of dust enclosures are included with dimensions for laying out an installation. Numerous typical installations are shown.

WHITING CORP., Harvey, Ill., in a new bulletin, No. 13, treats the Whiting impact pulverizer, giving illustrations of typical applications, general specifications for this equipment and describing the pulverizer in some detail.

ILLINOIS TESTING LABORATORIES, Inc., Chicago, Ill., has recently issued two bulletins. One of these, bulletin No. 1726, illustrates and describes the Alnor Pyroll Pyrometer for measuring surface temperatures of revolving rolls or driers. The other bulletin, No. 1727, covers the Alnor Pyrocon Combination Pyrometer and Type 1755 Pyrometer for measuring surface temperatures of flat surfaces such as molds, dies, platens, plates and other similar surfaces either metallic or non-metallic.

"HOW TO SELECT Insulated Cable" is the title of a new 80-page reference book published by the General Electric Co., Schenectady, N. Y. The publication covers cable for the transmission and distribution of electric power at normal frequencies, and presents in convenient form the information that is required in determining the cable best adapted for a particular installation. The more usual applications of cable are covered. Two methods of selecting conductor size are given. The first, a comparatively simple one, covers cable for wiring houses, buildings, small industrial plants, and similar applications. The other method, more detailed, includes 27 tables of current-carrying capacities.

GENERAL ELECTRIC CO. has just issued two new leaflets, GEA-1979 describing G.E. Reduced voltage starters and GEA-1953 on Magnet Wire and Coils. The latter describes the details of "bonded" insulation and "bonded" coils. In this type of construction, the insulation is firmly cemented to the wire, which prevents unravelling or slipping of the insulation when the wire is cut.

FOX ENGINEERING CO., Boston, Mass., is distributing a new folder describing its non-electric thermostatic valves for steam, gas and air control.

HAUCK MANUFACTURING CO., Brooklyn, N. Y., is distributing its bulletin No. 702, dealing with the Micro regulating valves used in the control of oil burners.

JOHNS-MANVILLE, New York, is distributing a folder describing the new 1900 deg. Superex insulating blocks developed by the company.

ROOTS-CONNERSVILLE BLOWER CORP., Connersville, Ind., in its bulletin No. 120-B10, describes the company's single-stage centrifugal blowers and exhausters, and in addition gives a table of capacities and characteristic curves.

STEPHENS-ADAMSON MFG. CO., Aurora, Ill., has just issued a bulletin dealing with Redler continuous flow conveyors. Many interesting installations are illustrated and the flexibility of application is pointed out in this bulletin.

AMERICAN DISTRICT STEAM CO., North Tonawanda, N. Y., recently issued a bulletin No. 211, devoted to a description of the use of the Adsco piston-ring expansion joint.

CENTRIFIX CORP., Cleveland, Ohio, in its bulletin No. 163, describes in detail the Centrifix internal steam purifier, and in addition gives technical information on its application and results obtained in delivering dry steam from the boilers.

PHILADELPHIA GEAR WORKS, Philadelphia, Pa., has just issued a very attractive bulletin entitled "Limitorque Control," which deals with the Philadelphia Limitorque control for power operation of valves, describing the details of construction and giving the many applications of this device.

NATIONAL REGULATOR CO., Chicago, Ill., is distributing a new folder describing a recently developed control known as Evenaire, for use in regulating the temperature of rooms heated by steam radiators.

THREE NEW ATTRACTIVE CIRCULARS describing air conditioning apparatus and the advantages of installations in offices, restaurants and apparel shops have recently been issued by the Westinghouse Electric & Manufacturing Company. These circulars, entitled, Level Off The Curve of Office Weather, Air Conditioning a Tested Recipe for Restaurant Profits, and Air Conditioning Custom Fitted For Stores and Shops include photographs of Westinghouse installations, clear, concise explanation of the unit air conditioning system and a complete description of each type of equipment. Copies of the desired circulars may be obtained from the nearest Westinghouse Air Conditioning Dealer or direct from the advertising department, East Pittsburgh, Pa.

THE BROWN INSTRUMENT CO., Philadelphia, Pa., has just published a new catalog on Brown hygrometers for recording and controlling humidity which illustrates the latest models of hygrometers and fully explains the various operating principles.

THE PARKER APPLIANCE CO., Cleveland, Ohio, has just issued its bulletin No. 37 dealing with Parker tube couplings and associated equipment, not only describing the various fittings manufactured by this company, but giving complete price lists and tables of various sizes.

WESTINGHOUSE ELECTRIC AND MANUFACTURING CO. has issued several new catalog sections as follows: Catalog section 41-350, a 4-page publication describing the Westinghouse Type SG Auxiliary Relays has recently been issued. This simple, low-cost, sturdy relay designed for opening or closing two independent circuits is especially applicable for use in industrial plants. The publication includes applications, distinctive features, application tables, dimensions, wiring diagrams and list prices.

Catalog Section 43-950 on the LE Photo-Relay describes the application, construction, operation, specifications, advantages, and list prices of these relays. These relays are applicable to all types of industrial control, light control, grading, counting, etc. The relay is available for either a-c. or d-c. circuits.

Catalog Section 31-575 on Polaricode Jr. Supervisory Control describes the application, distinctive features and operation of this low cost simplified supervisory control system. Especially applicable for small stations which do not justify the expense of higher cost systems, it is available in one size only and is limited to and equipped for a total of five selective, complete operations. It is ideal for the control of small hydro plants out on the creeks, oil line pumping stations, electric railway and mining substations, and municipal water pumping stations.

Catalog Section 41-505 describing Types CR and CRA Directional Overcurrent Relays. Intended primarily to sectionalize transmission lines, these relays may also be used for the protection of generators subject to feed-back from other sources. The leaflet contains the most complete information on the subject ever published including a discussion of applications, distinctive features, construction and operation. Also, wiring diagrams, time curves and prices are included.

Power Plant Construction News

Ala., Headland—Headland Ice & Cold Storage Co., plans rebuilding of portion of ice-manufacturing and cold storage plant, recently destroyed by fire. Loss about $35,000, including equipment.

Ark., Osceola — Common Council plans installation of new equipment in municipal electric light and power plant, including Diesel engine-generating unit and accessories. Fund of $52,000 has been secured through Federal aid.

Calif., Los Angeles—California Brewing Association of Southern California, 2060 East Forty-ninth Street, Vernon (Los Angeles) has approved plans for three-story power plant at new local brewery. Project will include a six-story brew-house, two-story bottling works and other units; electric power equipment will be installed. Entire program will cost over $500,000. E. L. Chaffee is engineer in charge of construction.

Calif., Los Angeles—Hughes-Mitchell Processes, Inc., 618 Majestic Building, Denver, Colo., plans construction of power house at new lead-zinc processing plant on tract of land on Normandie Avenue, Torrance, near Los Angeles, recently acquired. Manufacturing plant will comprise several units, with complete electrical equipment for operation. Entire project will cost over $500,000. W. H. Rose is president.

Calif., Riverbank—Riverbank Canning Co., Lorenzo Zorillo, head, plans installation of electric power equipment in new local winery. Proposed to begin work at early date. Cost about $75,000.

D. C., Washington—Acacia Mutual Life Insurance Co., 101 Indiana Avenue, plans installation of steam power station in new five-story office building on site bounded by New Jersey and Louisiana Avenues, First, C and D Streets. Cost about $1,000,000. J. P. Yort, vice-president, in charge.

Ill., Chicago—Paul Gerhardt, Sr., 64 West Randolph Street, architect, has plans nearing completion for two new distilling plants on sites in Illinois, for company whose name is temporarily withheld. Electric power equipment will be installed for operation; boiler plant will be built at each distillery. Entire project will cost about $300,000.

Ind., New Palestine—Town Council has appointed a special committee, headed by Charles Herrlich, chairman, to secure details and estimates of cost for new municipal electric light and power plant.

Ky., Frankfort—Kennebec Distillery, Frankfort, Carl J. Kiefer, Schmidt Building, Cincinnati, Ohio, consulting engineer, in charge, plans installation of electric power equipment in connection with extensions and improvements. Entire project will cost about $150,000.

Ky., Winchester—Bluegrass Brewery Co., plans one-story boiler plant at new brewery on East Washington Street. Electric power equipment will be installed for brewing service. Plant will have initial capacity of about 100,000 barrels per year. Cost about $120,000. R. Brooks Taylor is president.

La., Baton Rouge—Solvay Process Co., 61 Broadway, New York, N. Y., plans construction of power house and pumping station at new alkali and soda ash plant on large tract of land recently acquired at Baton Rouge. Electric power equipment will be installed in manufacturing units. Entire project will cost close to $4,500,000.

Me., Millinocket — Great Northern Paper Co., is completing plans for new hydro-electric power plant for paper mill operation. Cost close to $80,000. H. J. Deutschbein Co., Inc., 350 Fifth Avenue, New York, N. Y., is engineer.

Md., Carrollton—Trimble Distillery, Carrollton, operated by Republic Distillers, Inc., Schmidt Building, Cincinnati, plans installation of power equipment in connection with expansion and modernization program. Cost over $100,000. Carl J. Kiefer, Schmidt Building, Cincinnati, is consulting engineer.

Md., Cumberland—City Council is considering construction of municipal electric light and power plant, estimated to cost about $1,500,000. Public Ownership League, Isaac Hirsch, chairman, is active in project. Burns & McDonnell Enginering Co., 107 West Linwood Boulevard, Kansas City, Mo., is consulting engineer.

Mich., Detroit—American Malting Co., Dime Bank Building, has plans for large power plant at proposed new malt factory at Dix Avenue and River Rouge. Malt works will consist of several multi-story units, with electric power equipment for operation. Entire project will cost about $600,000. G. A. Mueller, 1346 Broadway, Detroit, is architect and engineer.

Mich., Detroit—Great Lakes Steel Corporation, Ecorse, a unit of National Steel Corporation, Grant Building, Pittsburgh, Pa., plans installation of motor-generator sets, motors and other electric power equipment in proposed new strip mill. Entire project will cost close to $10,000,000.

Mich., Wyandotte—Michigan Alkali Co. plans installation of electric power equipment in new multi-unit addition to alkali and soda ash plant. Cost close to $1,000,000. J. B. Ford is president.

Mich., Morenci—City Council has plans nearing completion for new municipal electric light and power plant and plans call for bids in near future. A fund of $125,000 is being secured through aid. Ayers, Lewis, Norris & May, Ann Arbor, Mich., are consulting engineers.

Miss., Canton — Common Council will have plans drawn by Black & Veatch, Mutual Building, Kansas City, Mo., consulting engineers, for welded steel pipe line and distributing system for natural gas supply from Jackson County fields, including compressor station, local distributing plant, etc. A fund of $100,000 has been arranged for program.

Mo., Trenton—City Council has plans maturing and is securing Federal loan and grant for $315,000, for new municipal electric light and power plant, and proposes early construction. Burns & McDonnell Engineering Co., 107 West Linwood Boulevard, Kansas City, Mo., is consulting engineer.

N. J., Millville—City Commission has authorized surveys and estimates of cost for new municipal electric light and power plant. Proposed to arrange necessary financing through Federal aid.

N. J., Paulsboro—Sandura, Inc., Finance Building, Philadelphia, Pa., plans installation of electric power equipment in new linoleum manufacturing plant at Paulsboro, to replace factory destroyed by fire a number of weeks ago. Cost over $100,000. Bids will soon be asked. Ballinger Co., Twelfth and Chestnut Streets, Philadelphia, is architect and engineer.

N. Y., Glens Falls—Imperial Color Works, Inc., Warren Street, plans installation of electric power equipment in new addition to dry color manufacturing plant. Cost about $40,000.

N. C., Lincolnton—Piedmont Municipal Electric Co., care of W. H. Childs, Lincolnton, city attorney, recently organized, plans construction of central generating plant, capacity about 50,000 kw., with transmission and distributing lines for light and power service at Lincolnton, Kings Mountain, Hickory, Shelby, Granite Falls, Morgantown and other communities in this district. Entire project will cost about $6,500,000. Financing will be arranged through Federal aid.

Okla., Cushing—City Council plans call for bids early in September for equipment for new municipal electric light and power plant, including Diesel engine-generating units. An electrical distribution system will be installed. Fund of $350,000 has been secured through Federal aid. W. R. Holway, 302 East Eighteenth Street, Tulsa, Okla., is consulting engineer.

Okla., Pawnee—City Council plans early call for bids for equipment for municipal electric light and power station. Fund of $60,000 has been arranged through Federal aid. W. R. Holway, 302 East Eighteenth Street, Tulsa, Okla., is consulting engineer.

Tenn., Knoxville—Tennessee Valley Authority, New Sprankle Building, plans early construction of new steel tower transmission line between Wilson and Norris power dams, including power switching stations and other line structures. Cost close to $2,000,000. Engineering department is in charge.

Texas, San Antonio—Colorado River Co., San Antonio, R. W. Morrison, head, plans hydroelectric generating plant at Hamilton dam, Colorado River, vicinity of Austin, in connection with completion of dam, now partially constructed and work inactive for number of months. Power station will be equipped for initial capacity of 20,000 kw. Transmission line and high-tension switching station will be built. A fund of $4,500,000 has been secured through Federal aid.

W. Va., Chester—Common Council is considering new municipal electric light and power plant. Cost over $100,000, with equipment, including transmission lines. Joel R. Taylor, mayor, is active in project.

Wash., Seattle — City Light and Power Department, J. D. Ross, superintendent, plans early call for bids for hydroelectric generating station, 65x225 ft., high-tension switching station and tail race for municipal power project at Diablo, Skagit River hydroelectric power development. A fund of $5,000,000 has been arranged for immediate work, to be increased to $13,000,000 for entire project.

Wash., Seattle—Silver Foam Brewing Co., W. H. Wilson, president, care of Henry Bittman, Securities Building, architect, plans installation of power equipment, refrigerating machinery, tanks, etc., in new multi-story brewery at Canal and West Fortieth Streets, Ballard district, for which bids will soon be asked on general contract. Entire project will cost about $200,000.